UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMSSION

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In the matter of:

METROPOLITAN EDISON COMPANY

(Three Mile Island Unit 1)

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Docket No. 50-289
(Restart)

25 North Court Street,
Harrisburg, Pennsylvania

Wednesday, November 12, 1980

Evidentiary hearing in the above-entitled matter was resumed, pursuant to adjournment, at 9:04 a.m.

BEFORE:

IVAN W. SMITH, Esq., Chairman,
Atomic Safety and Licensing Board

DR. WALTER H. JORDAN, Member

DR. LINDA W. LITTLE, Member

Also present on behalf of the Board:

MS. DORIS MORAN,
Clerk to the Board

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APPEARANCES:

On behalf of the Licensee, Metropolitan Edison Company:

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C O N T E N T S

P R O C E E D I N G S

CHAIRMAN SMITH: Ladies and gentlemen, the Board would like to be able to schedule the hearings during the period beginning December 22 through the first Monday following -- well, the final two weeks of the year. Dr. Jordan and Dr. Little will have to make airplane reservations now to be able to participate during those weeks, so we would like to have requests or recommendations from the parties in final form by Friday morning, if we can.

DR. JORDAN: In reviewing the testimony of Mr. Jones and Mr. Broughton, I find that I have asked most of the questions that I had with respect to that during the period when Mr. Pollard was cross examining, and so I have only one or two questions left.

Whereupon,

THOMAS GARY BROUGHTON and ROBERT C. JONES, called as witnesses by counsel for Licensee, Metropolitan Edison Company, having been duly sworn by the Chairman, resumed the stand, were further examined and testified as follows:

EXAMINATION BY THE BOARD -- Resumed

DR. JORDAN: In looking at NUREG-0565, I note that Item 2.1.2.d, the Evaluation of Safety Valve Reliability, was due for a completion on June 1 of this year, and what is the License's position with respect to that?

MR. BAXTER: Was that 2.1.2.d?

DR. JORDAN: 2.1.2.d, small d. I am looking at the table on page 211 of NUREG-0565.

WITNESS BROUGHTON: We have attempted to get some information on safety valve reliability. We are not aware of failures of safety valves in B&W plants. We discussed this more fully in another Contention. The people who are actually doing the work can address the issue more completely than I.

DR. JORDAN: I see. That will be addressed at a later time?

WITNESS BROUGHTON: Yes, it will.

DR. JORDAN: Then I would be glad to wait until that time.

Are you familiar with the work that is being scheduled for TVA on small break concerns, and particularly one of them 2.6.2.a, the experimental verification of two-phase natural circulation, which was due, apparently, for completion by January 1 of next year?

Are you following that work, or anyone in your organization following it, and why is it necessary to have an experimental verification?

WITNESS JONES: I am not -- well, we are trying to follow any data which is obtained on two-phased natural circulation. There have been various plans proposed using

the semi-scale facility, the LOFT facility, to run some tests, including effects of non-condensable gases, but I am at this time not aware that they have been finalized.

As far as the general requirement listed in the recommendation, which is to benchmark your codes versus experimental data, at the present time we don't see a -- well, the data is not available. If such data becomes available, I am sure we will look at it. We do not have any formal times to, at this time to totally address this concern.

I would like to note just in a very general fashion relative to the whole issue of 0565, the staff has required the Licensees to provide a response to one of the items, I don't remember the specific number, in the Task Action Plan, which references 0565. That response is due to the staff, as I stated earlier I believe, in mid-November, sometime in that timeframe. Subsequent to the Licensees responsees, the staff and the Licensees are supposed to sit down and discuss further the staff's concerns, exactly what the staff feels is necessary to respond to these concerns, and to develop a program which will be acceptable to the staff, and then such work is to progress.

But at this time, the actual resolution items or what they will be is still up in the air.

DR. JORDAN: Well, is it not true that many of

your analyses have depended upon an understanding of two-phased flow, and aren't you relying on those analyses and the liquid and fluid performing as you indicated?

WITNESS JONES: For the very small breaks, we do use the boiler condenser mode to -- it is used to remove a fairly large portion of the decay heat being added to the system. For the design basis small breaks we do not really rely on it. We dissipate very little energy to the steam generator when we hit the boiler condenser type mode, and in fact, as the analyses have demonstrated, we really do not need the steam generator as a heat rejection, for heat rejection for the larger sized design basis small breaks, but for the smaller breaks, where we use the two-phased natural circulation or the boiler condenser mode, those breaks have fairly large margins to core uncovery. The system remains rather full, and that any uncertainties in the heat transfer would not be expected to result in core uncovery.

DR. JORDAN: Well, is it just a matter, then, of uncertainty as to how much heat is transferred from the core to the steam generator, or -- well, what is the history or the past with respect to two-phased flow and how much reliance can you put in in those calculations?

WITNESS JONES: I would say that the uncertainty, if you wish, in the calculation would be relative to the

amount of heat transfer for the given heat system condition, that is, the amount of exposed surface area and the delta T between the primary and secondary side. But it is not, as I stated, it is really not that important that you know that accurately in that all you need to do is adjust the delta T a little bit or adjust the exposed surface area, and you will get the same heat transfer.

In looking at what the computer codes are calculating for this heat transfer, comparing it to some of the classical heat transfer models such as the Neuschel condensing model, it turns out to be in fairly good agreement.

DR. JORDAN: This is an area in which I somehow lack completely any knowledge of, and that is two-phased flow, but you say there are classical experiments, and it is a matter of not whether it works or not, but whether you get a certain heat transfer rate, or 50 percent more.

Is the uncertainty, then, on the order of 50 percent, or are they a factor 10 is what I don't know.

WITNESS JONES: Well, in fact, we could absorb a factor of 10 in our model, and it would not be expected to get the core uncovered.

In general, the classical model is a laminar type heat transfer model where they have heat transfer through a laminar film on the condensing surface, and in general, that

will tend to underpredict heat transfer, and in fact, if you get a large film built up on the tube, a liquid condensing film, you will get turbulence in mixing which will greatly enhance the heat transfer which the classical model will not pick up.

Now, there are other models based on some experimental data which shows what it looks like.

Now, most of this data, however, is not at high system pressures. There is no reason to believe that the classical derivation would be in large error, but what the staff is asking for or looking at here is get some data at these high pressures and system conditions just to verify the accuracy or applicability of these classical models.

DR. JORDAN: Is there a fair amount of data from, for example, distillation columns, things of that nature, so that one can get the heat transfer within the ballpark?

WITNESS JONES: I am not really sure what the total experimental data picture looks like, but the process we are talking about is basically very similar to what you have with a condenser on a plant. So there is some -- there are some bases, the basic phenomenon works. It is just the matter of how accurate is the code in predicting that phenomenon.

DR. JORDAN: I see.

One other question. You discuss the need for

reactor coolant pump trip and the signals that the operator would get which require -- indicate to him that the reactor coolant pump trip is needed.

Now, how does operator know when to restart the cooling pumps? What is the criteria? What are the criteria there? And could he make a mistake and restart it at just exactly the wrong time?

WITNESS JONES: Well, the criteria has been developed so he does not do that in the operating guidelines that B&W has developed, and there are several times under which you can start the reactor coolant pump. The first one is if the system remains in a subcooled state, at 50 degrees subcool which indicates that either he doesn't have a LOCA or he is supplying injection at a rate equal to or in excess of the leak. There are other criteria where, if the system pressure goes above 1600 psi, that is allowed to restart the reactor coolant pump, assuming feedwater is available, which is a precondition on that start, and at -- breaks that would lead to those type of system pressures are very small and are outside of that region of break sizes which could cause problems. And there are some bumping the pump procedures that are employed within the guidelines which are basically if you have a large difference between the primary side pressure and the secondary side pressure indicative of a decoupling of the primary and the secondary side; that is,

you are not transferring heat because you have a bubbe blocked in the upper candy cane which means a very, a relatively small void relative to the whole primary system volume, and we bump the pump several times, and that if that has not gotten rid of the bubble totally after I think it is the fifth or sixth pump bump, you can allow the pumps to continue to run.

Other circumstances, there are other circumstances where pump starts are allowed, and those are specifically when we have inadequate core cooling indications, that is, that for some reason the transient has progressed beyond what we call the design basis events, what we have analyzed, and for those circumstances, the NRC has directed that guidelines be developed. Such guidelines have been developed, and they call for pump restarts when the in-core thermocouples indicate a significant amount of superheating exiting the core, which is indicative of potentially a large core uncovery.

DR. JORDAN: Potentially what?

WITNESS JONES: A large core uncovery, a large portion of the core is not covered by a steam-water mixture.

DR. JORDAN: And you say that under that circumstances, restart of the pumps could be allowed?

WITNESS JONES: Yes.

DR. JORDAN: It seems to me that is the very case

where you would have a two-phased mixture and proceed to letting all the liquid or the mixture get out the break, that that is the very case you don't want the pumps to go.

WITNESS JONES: The general reason for starting the pumps under that scenario is first off, you have -- the guidelines are non-mechanistic in the sense that we are postulating that you somehow reached this condition. It may be because you have substantial equipment problems in the plant. It may be because of many operator errors. You know, for any circumstance, the criteria at this time, or what we were looking for when we developed these guidelines were to -- we were recognizing we were beyond where we should be, that there is something more wrong than would be expected, and our first priority was to keep the core cool. The starting of the reactor coolant pumps in this condition will tend to cause flow. It will tend to depress the downcomer water level and recover the core. It will probably not cause a complete loop flow. It will hit a slug of water into the core, depress the downcomer water level, which will raise the two-phase mixture over the core, but then it will probably be just pumping steam because you have a basically empty system, and you will not be able to develop enough driving head with the pumps to overcome the thirty foot height in the hot legs, 35, 40 foot height in the hot legs that you have to push the water over, and the

basic reason to start the pumps were to provide some time for the operator to take other actions such as depressurization of the steam generator, to provide a little more cooling under a steam flow situation. With a flowing reactor coolant pump you will get some more cooling. All those sorts of items, we felt the first priority had to go to protecting the core.

So we are starting the reactor coolant pumps at that time and basically saying from a probabilistic sense we would not expect to lose the reactor coolant pumps shortly thereafter. At that point in time we are in trouble and we have got to take whatever actions are available to us, so we start the pumps.

DR. JORDAN: But during the TMI 2 accident, there was considerable uncertainty as to whether the pumps should be restarted or not, and whether they should be shut off or not, and why will we now be in a much better shape? Are the procedures such now that they would have, if followed during the TMI 2, they would have recovered the core?

WITNESS JONES: Well, the whole TMI sequence is not really related to how the pumps were operated.

DR. JORDAN: Oh, I undestand that. The problems there were much worse. But there was, nevertheless, great uncertainty on the part of the operators as to whether they should start the pumps or not.

How are they better off now?

WITNESS JONES: Well, they do have now specific criteria for starting the pumps.

DR. JORDAN: They do have specific criteria.

WITNESS JONES: Yes, and these are based on our B&W guidelines, and in fact, if you look at the TMI sequence, when they started the reactor coolant pumps, it would be basically the same times that the B&W guidelines would say to start the reactor coolant pumps, especially the one at 16 hours or thereabouts in the transient.

DR. JORDAN: Especially what?

WITNESS JONES: The one where they started the pump continuously. They did start a pump earlier, at around 2 3/4 hours, or to 3 hours, in that timeframe, and that again would probably be within the guidelines from the inadequate core cooling procedure.

DR. JORDAN: Well, do the guidelines say, for example, that if "vibration is observed" don't start or shut it off?

WITNESS JONES: With the guidelines that have been developed for the normal small break situation that is not leading to inadequate core cooling, you would not see pump vibrations because you have basically a full system or in fact a totally full system.

For the inadequate core cooling procedures, we

have directed them to just start the pumps somewhat irregardless of vibration, but there may be other recommendations, depending on where you are in the inadequate core cooling procedure, what level you are at, whether to watch out for vibrations. But you are allowed to at least exceed normal vibration limits.

DR. JORDAN: All right.

Supposing now I am an operator. I have tripped the pumps because certain criteria have been met. I now wonder whether I should restart them or not.

What does he do? Does he go to this procedure, read and see what happens, see what he should do?

WITNESS JONES: Basically that is correct. It is not an immediate action that he has to take. It is one of the follow-up actions. Later in the transient he goes to the -- he will be following his procedure in the follow-up action portion. So he has time to read and decide.

DR. JORDAN: Would it be kthe same procedure that told him to trip the pumps?

Well, it doesn't matter.

WITNESS JONES: I'm not really sure. There are many procedures that he could get through.

DR. JORDAN: Okay.

Well, thank you gentlemen very much. I think that is all the questions I have.

CHAIRMAN SMITH: Anything further?

Ms. Weiss?

MR. BAXTER: Mr. Chairman, may I?

REDIRECT EXAMINATION

BY MR. BAXTER:

Q Mr. Broughton, with respect to your testimony on the TMI 1 procedures that implement the B&W Small Break Operator Guidelines, you were asked particularly in connection with tripping the reactor coolant pumps what kind of indication the operators had which would have enabled them to distinguish a low reactor coolant system pressure initiation of ESFAS versus an ESFAS caused by, for example, high reactor building pressure.

Do you have additional information this morning to supplement your testimony on that?

A (WITNESS BROUGHTON) Yes, I do. There are enunciators which are alarms in a panel high in the control room, over the control panels, which would allow the operator to distinguish between high pressure injection initiation due to low reactor coolant system pressure at 1600 pounds. There is an individual alarm for that condition. And there is a separate alarm for initiation of high pressure injection due to 4 pounds in the containment building. So those two alarms would allow him to make the distinction.

In addition, there are pressure indicators for both the primary system pressure which would allow him to verify the pressure was below 1600 pounds, and there is also a pressure indicator for the reactor building pressure which would allow him to determine exactly what the reactor building pressure was.

So his requirement to trip pumps when reactor coolant system pressure decreases below the 1600 pound initiation set point can be determined by him observing the alarm, the enunciated alarm, and by the pressure indications that he has.

CHAIRMAN SMITH: That four pound containment building pressure, what effect does that have on the high pressure injection pumps?

WITNESS BROUGHTON: If the reactor building pressure reaches four pounds, that will start the safeguard systems, including the high pressure injection system, just as if the primary system pressure had dropped below 1600 pounds. Either one of those two conditions will cause the safeguard systems, the high pressure injection system, to start.

DR. JORDAN: It is presumed, of course, that the high reactor building pressure is a result of a break, and

[illegible]amm in the reactor building, is that right?

WITNESS BROUGHTON: Yes, particularly in the case

of a large reactor coolant system rupture. The four pound pressure signal would initiate very quickly in that sequence.

CHAIRMAN SMITH: Go ahead.

MR. BAXTER: I have no other questions.

CHAIRMAN SMITH: Ms. Weiss.

MS. WEISS: We have some questions on the procedures which we were given yesterday and looked at overnight, and I will have Mr. Pollard do those, and then I will just have a couple after that.

RECROSS EXAMINATION

BY MR. POLLARD:

Q Mr. Broughton, if I could first follow up on the additional testimony you have given this morning in response to questions by Mr. Baxter, did you have an opportunity to review the information provided by the status panel on the status of components in the emergency core cooling systems?

A (WITNESS BROUGHTON) I did not review the status panel in detail.

Q So you still don't know whether that Status Pawnel would look exactly the same, whether the ESFAS signal was initiated by lower reactor coolant system pressure or high reactor containment building pressure.

A (WITNESS BROUGHTON) My understanding is it would look the same, but since I have not looked at it in detail, there may be differences that I am not aware of.

Q Is it correct then it is your opinion now that you cannot use that status panel as an additional indication of whether or not the reactor coolant pumps should be tripped?

MR. BAXTER: Objection, Mr. Chairman. The witness has stated that he has not reviewed it and he cannot testify whether there are differences.

MS. WEISS: He testified yesterday that it was an additional signal, and if he has not reviewed it -- well, he had to have some knowledge to base his testimony on yesterday. I think it is an absolutely fair question.

MR. BAXTER: I appreciate the ruling.

CHAIRMAN SMITH: I beg your pardon?

MR. BAXTER: I am just going on the testimony he has given this morning, Mr. Chairman.

CHAIRMAN SMITH: Well, let's go through it and see how it comes out.

Go ahead. You may answer.

WITNESS BROUGHTON: I am not sure if by looking at the status panel he can determine whether the initiation was caused by four pounds in the containment building or by 1600 pounds in the reactor coolant system.

BY MR. POLLARD: (Resuming)

Q If we can turn now to the emergency procedures, I believe yesterday you referenced Emergency Procedures 1202-4, Revision 17, 1202-6A, Revision 4, and 1202-6B,

Revision 4, as being used as the basis for your testimony on UCS Contention 8 and ECNP Contention 1E, as well as your testimony on response to the Board questions on UCS Contention 8, is that correct?

A (WITNESS BROUGHTON) Yes.

Q Would you look first, please, at Emergency Procedure 1202-4. I note that in general most of the emergency procedures, including this one, as the first three main sections are labeled "Symptoms," "Immediate Action," and then "Follow-up Action."

Am I correct in assuming that the Symptoms section would be used by the operator to determine which emergency proccedure he should use, is that correct?

A (WITNESS BROUGHTON) Yes, that is correct.

Q And the Immediate Action section is the section that the operators are supposed to have memorized and can perform rather rapidly after the accident, is that correct?

A (WITNESS BROUGHTON) That is correct.

Q And that in the Follow-up Actions section at this point, we can assume that the operator may have to actually take out the procedure and review it to decide what to do. Is that correct?

A (WITNESS BROUGHTON) That is correct.

Q If we could turn to the Immediate Action section of 1202-4, which begins on page 2.0, please, on Step B-1 of

manual action, is it correct that if some of --

DR. JORDAN: I think if you just read what Step B-1 is, wek can follow.

MR. POLLARD: I'm sorry.

BY MR. POLLARD: (Resuming)

Q Step B-1 states, and I quote, "Manually trip the reactor and verify that all rods are inserted except Group 8 by observing the green in-limit lights. If one or more rods are stuck out, commence emergency boration."

Is it correct that in that step, that if he found one or more of the control rods were not fully inserted, he must stop at this point and take other manual action, specifically, whatever actions are required for emergency boration?

A (WITNESS BROUGHTON) My understanding of the way the procedures are used to deal with an event like that would be that the action for emergency boration would be initiated in parallel with other actions required following the trip. So I don't think that he would stop here and go to another procedure. I believe that he refers to another procedure, executes those steps in addition to the ones that are required by this procedure.

Q But there are additional manual actions that the operator would have to take if some of the control rods were not fully inserted, compared to the situation where the rods

were all fully inserted.

A (WITNESS BROUGHTON) I am not fully familiar with exactly what would be required for emergency boration, so I don't know if there are other manual actions or not.

Q Step B-2 states, "Trip the turbine, verify that the turbine stop valves are closed and that the generator breakers are open, and start lift pumps and turning gear oil pump."

Does that step also involve manual actions that the operator must take?

A (WITNESS BROUGHTON) Again, I am not familiar enough with exactly what is required to perform those steps. From the way it is worded, it would imply that manual actions might be required, but I don't know that that is in fact the case., It is possible that some of those pumps, or all of them, might start automatically.

Q Step B-3 states, "Monitor pressurizer level and maintain level greater than or equal to 100 inches. Start second make-up pump (MU-P 1A or 1B) and open MU-V 217. If make-up tank level reaches 55 inches, shift pump suction to the BWST by opening MU-V 14A and closing MU-V 12."

Does that step involve additional manual actions that the operator must or is directed to take?

A (WITNESS BROUGHTON) Yes. Some of those valves that would be required to be opened and closed would be

opened and closed by manual action of the operator.

DR. JORDAN: Mr. Pollard, I have lost track a little bit. What was this manual procedure for?

MR. POLLARD: Perhaps I don't understand your question.

DR. JORDAN: What is the title of the procedure? What is the operator trying to do?

MR. POLLARD: The emergency procedure I am working from is 1202-4, Revision 17. Its title is Three Mile Island Nuclear Station Unit No. 1, Emergency Procedure 1202-4, Reactor Trip.

DR. JORDAN: Reactor Trip?

MR. POLLARD: Yes, sir.

DR. JORDAN: Okay, I see. Now I understand.

CHAIRMAN SMITH: Where does the action lead to?

MR. POLLARD: As we continue through this procedure, we will eventually get to instructions dealing with the tripping of the reactor coolant pumps and instructions dealing with the operator action in throttling high pressure injection.

CHAIRMAN SMITH: That is why I am wondering why you are referring to a single operator throughout these questions, you seem to be.

I mean, is that just a way of referring to the collective organization and duty in the control room, or are

you literally referring to an operator, a single operator?

MR. POLLARD: It is in my question, I guess I am using the word "operator." The procedures themselves don't way one way or the other. I am aware, of course, of earlier testimony that there will be an additional operator in the control room.

MR. BAXTER: I believe the earlier testimony was more than one additional oprator.

CHAIRMAN SMITH: All right.

BY MR. POLLARD: (Resuming)

Q We are now on page 3, Step B-4 which states, "If reactor power is not less than 10 percent within one minute following the reactor trip, commence emergency boration."

Is your answer here the same, that you don't know whether or not any manual operator actions are required for emergency boration?

A (WITNESS BROUGHTON) That is correct.

Q Step B-5 states, "Verify that OTSG level is decreasing to 30 inches on the start-up range (50 percent on the operating range if all four reactor coolant pumps are off). If any feedwater stations are in hand, manually control feedwater flow to maintain the appropriate steam generator level."

Does this step also require other manual operator actions?

A (WITNESS BROUGHTON) This would require manual action only if the feedwater system had not been in automatic, which is the normal mode that it would operate in.

Q If it is on automatic, is the feedwater system controlled by safety grade equipment or non-safety grade equipment?

A (WITNESS BROUGHTON) The control of feedwater is by non-safety grade equipment.

Q We now commence into the section 4.3, which is Follow-up Actions.

Step 4.33 states, "If the pressurizer level drops below 80 inches, verify pressurizer heaters are off. If not off, place the heater control switches to off in the control room" -- excuse me, "If not off, placew heater control switches to off on Console CR."

Does this step perhaps require additional manual operator action?

A (WITNESS BROUGHTON) If the automatic system did not function to turn the heaters off, then the step would require manual action.

Q Is the automatic system which controls the heaters safety grade or non-safety grade?

A (WITNESS BROUGHTON) That is a non-safety grade system.

Q Now, we get to Step 4 which states -- this is

4.3.4 -- "If pressurizer level drops below 20 inches, manually initiate high pressure injection. HPI may be throttled when pressurizer level is restored if a 50 degree margin from saturation is present."

Comparing this instruction with your testimony on page 10 and 11 of your direct testimony on UCS Contention 8 and ECNP Contention 1E, I notice that the emergency procedure does not specify the additional requirement that it may be throttled only if reactor coolant system pressure is above 1600 psig, as stated in your direct testimony.

Can you explain the apparent conflict between your testimony and Emergency Procedure 1202-4?

A (WITNESS BROUGHTON) Well, the step we have just looked at in the emergency procedure comes before Step 6 on the following page, which gives direction if the reactor coolant system is less than 1600 psi. So Step 4, the instruction to start high pressure injection and throttle if 50 degree subcooling margin is restored assumes that the pressure is above 1600 pounds.

Q Step 6 deals with tripping the reactor coolant pumps, isn't that correct?

A (WITNESS BROUGHTON) That is correct.

Q And the step I am questioning you about deals with throttling high pressure injection, is that correct?

A (WITNESS BROUGHTON) That is correct.

Q Okay. We will eventually get to questions on the reactor coolant pump trip. Right now what I am trying to focus your attention to is the statement in your direct testimony which states, and I quote, "In situations where high pressure injection is manually initiated, flow reductions are permitted only if reactor coolant system pressure is above 1600 psig and the 50 degree subcooling margin exists and can be maintained, or if the criteria for flow reductions following automatic initiation are satisfied."

And the point I am trying to question you on is the step 4.3.4 in Emergency Procedure 1202-4 tells the operator that he may throttle high pressure injection without regard to the pressure. There is no indication in the emergency procedure that pressure is something he should worry about.

A (WITNESS BROUGHTON) Well, in following this procedure, should pressure drop below 1600 pounds, he is then referred to actions in a different procedure, the loss of coolant procedure, and in that case, the loss of coolant procedure provides criteria for throttling high pressure injection.

Q Step 4.35 states, "Verify that turbine by-pass control valves are maintaining header pressure at 1010 psig." If, on reaching that step he finds that pressure is

not being maintained at that point, would that require him to take further manual operator actions?

A (WITNESS BROUGHTON) Yes, that would.

Q Now we are up to Step 4.36 on page 4 which states, "If RCS pressure decreases to the ESAS actuation set point (1600 psig) an immediate trip of all reactor coolant pumps is required. Refer to EP 1202-6, 'Loss of Reactor Coolant/-Reactor Coolant Pressure.'"

How many different procedures are there in Emergency Procedure 1202-6?

A (WITNESS BROUGHTON) There are three different sections of that procedure.

Q And do those three different sections also have multiple attachments?

A (WITNESS BROUGHTON) Two of those three procedures have additional attachments.

MS. WEISS: The Board has one of them. It is UCS Exhibit 1202-6B, I guess.

MR. POLLARD: Except the Board will recall the revision is one exhibit earlier, and as we understood it, the only difference between Revision 3 and Revision 4 was that they had added the valve number, as I recall for the PORV.

BY MR. POLLARD: (Resuming)

Q My question at this point, Mr. Broughton, is

considering all of the immediate manual actions that the operator has to take, and considering that if some of the non-safety equipment does not perform as expected, and that would require additional operator action, and considering he does not even get to the follow-up section of this procedure when I understand you to say it was expected he may actually have to read the procedure to find out what to do next, I am wondering whether you have any opinion as to whether or not he will ever get to Step 4.36 within three minutes after the initial accident begins.

A (WITNESS BROUGHTON) I think it is quite likely, because there are other ways that he would be referred to the loss of coolant accident procedure, those being symptoms of loss of coolant accidents, which would be decreases in pressure, increases in building -- decreases in reactor coolant system pressure or the increases in reactor building pressure, or any one of several other symptoms which he also memorizes as part of his qualification, and the initial actions of the loss of coolant accident procedures are also ones which he is able to execute without referring to the procedure.

So if conditions were to arise which would cause reactor coolant pump trip, those would be executed by the operator from memory, in spite of where he was within another procedure.

Q Did I understand you earlier that you had not really examined the procedures necessary for emergency boration, that you are not really sure of what manual operator actions are required in some of these steps?

Is that your testimony?

A (WITNESS BROUGHTON) That is correct.

Q And in spite of not knowing what those manual operator actions are, you still believe that he is going to get to Step 4.36 or an equivalent action in another procedure within three minutes.

A (WITNESS BROUGHTON) My statement was that it was not necessary for him to get to Section 4.36 to identify that he had a loss of coolant accident which required him to execute the immediate action steps for the loss of coolant accident procedure.

Q But of course you recognize that this step is not an immediate action step, it is a follow-up step.

A (WITNESS BROUGHTON) It is a follow-up step in the reactor trip procedure. However, if he identifies that he has a loss of coolant accident, then he would begin to execute the immediate action steps of the loss of coolant accident procedure.

Q Can you be more specific as to precisely how he would get into which specific other procedures?

MR. BAXTER: I'll object. I don't believe there

is a foundation for the question. The witness testified that the operator would not have to refer specifically to the other procedure, that is immediate, and immediate action which he would take from memory based on his reading of the symptoms of the LOCA.

MR. POLLARD: Well, perhaps this witness then could answer the question from memory.

MR. BAXTER: He is not an operator.

BY MS. WEISS: Then tell us exactly what symptoms would trigger what immediate actions which are memorized, and where those immediate actions appear in any emergency procedure. We have got to be able to pin this down.

A (WITNESS BROUGHTON) Well, the situation we have been discussing where reactor coolant system pressure decreases below 1600 pounds is a symptom which is covered by 1202-6B, the procedure which discusses loss of coolant accidents which result in automatic initiation of high pressure injection.

CHAIRMAN SMITH: Ms. Weiss, I would like to remind you that the agreement on having Mr. Pollard examine anticipated at the very least that only one examiner on one question.

MS. WEISS: I haven't been asking questions. I have just been responding to objections. I think that I am in a better position to do that. I have not been asking the

questions.

CHAIRMAN SMITH: I did not appreciate the difference.

BY MR. POLLARD: (Resuming)

Q Would you agree that until the reactor coolant system pressure decreases to 1600 pounds, it could very well be that the operator is going through the steps in Emergency Procedure 1202-4?

A (WITNESS BROUGHTON) Following a reactor trip, if there were no other symptoms of abnormal conditions, then the operator would strictly be going through the steps in the reactor trip procedure.

Q And the symptoms of abnormal conditions, as I understood you, was reactor coolant system pressure decreasing to 1600 pounds.

A (WITNESS BROUGHTON) I did not state explicitly that that was a symptom. There are many symptoms identified for each of the different casualty procedures.

Q Mr. Broughton, perhaps if I slow down we can understand each other better.

CHAIRMAN SMITH: I -- well, never mind. You are verging on the impertinent.

MR. POLLARD: Sir, it may be my fault, not the witness'.

CHAIRMAN SMITH: Well, let's just take it for

that, yes.

It's okay. I just want to warn you that this is one way in which it could be perceived, and you have explained it.

BY MR. POLLARD: (Resuming)

Q I originally asked you the question of whether or not we were following along the steps in Emergency Procedure 1202-4, and as I understood your answer, you said that other things might occur in the plant which would direct the operator to Emergency Procedure 1202-6B, and I understood your answer to that question to be a decrease in reactor coolant system pressure to 1600 pounds would automatically initiate high pressure injection, and it would be that event which would cause the operator to go to Emergency Procedure 1202-6B.

I then asked you a question was, until the reactor coolant system pressure decreases to 1600 pounds, is it not possible that the operator would be following along the steps in Emergency Procedure 1202-6.

Now, is there anything in what I have just explained that you disagree with?

A (WITNESS BROUGHTON) No.

BY MR. POLLARD: (Resuming)

Q I have just one further question on 1202-4. It is on page 5, Step 12. This is also a follow-up action. It

states, "Verify that the pressurizer code safety valves and RCRV 2 (PORV) are closed by verifying that the discharge delta P indicators indicate approximately zero, that no flow alarm is indicated on the acoustic monitor for the RCRV 2 (PORV), and the demand indication for RCRV 2 (PORV) indicates closed."

My question is, what should the operator do if he verifies, in fact, that the pressurizer code safety valves are not closed?

MR. BAXTER: Objection, Mr. Chairman. As I understand the relevancy of his interrogation on this procedure, it is to -- and I am guessing -- to show that in addition to tripping the reactor coolant pumps, the operator may have other actions he is required to perform or to verify that the procedures indeed contain the criteria for throttling or terminating high pressure injection that Mr. Broughton testified to.

I don't relate this question or this follow-up action to that direct testimony at all, and I object to this being outside the scope of the direct.

CHAIRMAN SMITH: Ms. Weiss?

MR. POLLARD: We can have the question later on another Contention dealing with the safety valves.

CHAIRMAN SMITH: Give us just about two minutes here to consult.

(Pause)

CHAIRMAN SMITH: Go ahead.

You may proceed.

BY MR. POLLARD: (Resuming)

Q If we could go now to Emergency Procedure 1202-6A, Revision 4, which is entitled, "Loss of Reactor Coolant/Reactor Coolant Pressure Within Capability of Make-Up System (RC Pressure above ESAS Set Point)," Mr. Broughton or Mr. Jones, can you tell me what size break is within the capability of the make-up system, in other words, what sized break would this procedure apply to?

A (WITNESS JONES) I am not really sure. It would be a break less than .005 square feet, because that is one that is matched by the high pressure injection system when it is actuated. It is going to be dependent somewhat of the location of the break and the number of HPI or make-up pumps that you have actuated. For example, if you actuate a second make-up pump or actuate an HPI pump in conjunction with the make-up pump, it would be a bigger size, but I am just not sure what the exact area is. It is definitely less than the .005 square foot break, though.

Q When you say actuate an HPI pump in addition to a make-up pump, it is somewhat confusing, as I understood these pumps are the same.

Do they operate differently whether they are being

used as make-up or high pressure injection?

A (WITNESS JONES) Well, they do actuate differently from the sense that if you -- what I am talking now about actuate an HPI or make-up pump, they are the same pumps. The paths they take are different to the system.

Now, if you actuate an HPI at high pressures, you would be pushing the pump or adding fluid through the make-up line, which is a lower capacity, or a higher resistance line, and therefore you get lower flow into the system.

If you get an Engineered Safety Features Actuation Signal, then you would go through the HPI line, which has less resistance, and you get more flow out of the pump.

Q If we look now on page 2 again, the immediate actions, the manual immediate actions, Step B-1 states, "Verify MUV 17 open and pressurizer heaters on," and that step is followed by a note which says "In case of power failure to the pressurizer heater motor control centers, transfer one group (group 8 or group 9) to the 480 volt ES bus per EP 1202-29."

Does this require some additional manual actions by the operator?

A (WITNESS BROUGHTON) I believe it does.

Q Step B-2 on page B-3 says "Close or verify MUV 2A, MUV 2B, and start additional MU pump (normally MUP 1A).

Open MUV 217, if necessary, and maintain pressurizer level at approximately 220 inches."

Does that step require or perhaps require additional manual operator actions?

A (WITNESS BROUGHTON) Yes.

Q Step B-3 states "Reduce flow to 10 percent per minute and commence shutdown using OP 1102-10."

Does that step require manual operator action?

A (WITNESS BROUGHTON) Yes.

Q Step B-4 reads, "Line up a waste transfer pump to the borated RC bleed tank and pump to the make-up tank to maintain the required level, and if make-up tank level goes below 55 inches, open MUV 14A (B) as required to maintain make-up tank level."

Does that step require manual operator action?

A (WITNESS BROUGHTON) Y s.

Q Step B-5 reads, "Verify that RCRV 2 is closed, and close RCV 2 (RCV 2 may be reopened if necessary to control pressure.)"

Does that step require manual operator action?

A (WITNESS BROUGHTON) Yes.

Q Step B-7 states, "Trip the reactor, initiate high pressure injection, close MUV 12 and perform immediate actions of 1202-4 if any of the following occur: A, make-up tank level decreases to 40 inches; B, pressurizer level is

less than 200 inches and decreasing with MUV 217 open; C, reactor building RP pressure reaches 2 psig or average RV temperature exceeds 140 degrees Farenheit."

Does that step require manual operator action?

A (WITNESS BROUGHTON) Yes.

Q Step 8, "Verify main feedwater is maintaining OTSG level at the required level for reactor power at greater than or equal to 30 inches on the start-up range."

Does that step require operator action?

A (WITNESS BROUGHTON) The only action there would be to verify a reading. It would not require manipulation of a contro.

Q Is this equipment that would otherwise automatically maintain the steam generator level safety grade or non-safety grade?

A (WITNESS BROUGHTON) It is non-safety grade equipment.

Q Then we get to Step B-9 which states, "If the RCS pressure reaches the ESAS actuation set point, 1600 psig, A, trip all operating RC pumps; B, verify HPI is initiated; C, verify that EFP 1, EFP 2A, and EFP 2B start, verify discharge pressure is greater than 1010 psig, and take manual control and open EFV 30A and B and verify EFW flow to increase OTSG level to 95 percent on the operating range; D, perform the actions required by the follow-up action in

1202-6B, 'Leak/Depressurization Causing Automatic ESAS Actuation.'"

Now, considering the instructions here for tripping the reactor coolant pumps and considering your direct testimony on when the operator should trip reactor coolant pumps, my question is again as it was somewhat yesterday, assuming that the reactor coolant pressure is decreasing, and that the operator manually initiates high pressure injection before the pressure reaches 1600 pounds, and that action results in terminating the pressure decrease so that it never gets to 1600 pounds, under those circumstances the operator is not instructed to trip the reactor coolant pumps, is that correct?

A (WITNESS BROUGHTON) That is correct.

Q I have just a few questions on your testimony yesterday. It might be helpful to you if you had yesterday's transcript in front of you.

On page 5275 --

MR. BAXTER: Excuse me, Mr. Pollard, we are short one transcript.

Could we have a two minute pause.

(Pause)

MR. BAXTER: Thank you. We are ready.

BY MR. POLLARD: (Resuming)

Q On page 5275, in answer to a question from Mr.

Baxter, your answer beginning at line 9, you state, "We were discussing the conditions under which an operator would trip reactor coolant pumps, and by some inconsistent use of terminology on my part, I confused what the operators had been told to do through their training and their procedures."

My question is, Mr. Broughton, given your professional qualifications compared to the required qualifications of reactor operators, if you become confused on the terminology of emergency procedures, don't you think it is possible that the operators might also become confused, particularly in the midst of an accident?

MR. BAXTER: Objection. I would have to review the transcript, Mr. Chairman. I see no evidence of Mr. Broughton's confusion.

CHAIRMAN SMITH: Well, overruled.

DR. LITTLE: Line 12 on page 5275.

CHAIRMAN SMITH: He was actually reading from the transcript. He said he had confused, and I think that the question is an ambiguous question -- I mean, the answer is ambiguous and it needs to be explained.

MS. WEISS: The witness may answer the question.

WITNESS BROUGHTON: My familiarity with the operating procedures used at TMI 1 is much different than the familiarity that the qualified operators would have for those procedures. I do not deal with these procedures on a

daily basis. I review analysis that may go into preparing the procedure, but I don't prepare the procedures either. The procedures are prepared lby people who are familiar with the indications available in the control room. They use a standard set of terminology to prevent ambiguities or confusion, and the operators learn those standard sets of terminology, they memorize the symptoms, they know the conditions under which they should take certain actions. Those are things that I do not get involved with in my daily activities in providing engineering support to the operating plant.

So I don't think that because I got confused on terminology, or may have answered a question without giving proper thought to the terminology is any indication that an operator would do the same thing.

Q Then is it your testimony that you personally have no basis for judging whether or not the operators might become confused during an accident?

A (WITNESS BROUGHTON) I do not.

Q If I could direct your attention now to page 5347 of the transcript, if you could read to yourself there the question that was asked and the answer you gave in lines 1 through 12.

(Pause)

If I understand your answer, what you stated there

was that there might be some secondary overcooling events which would cause both a lower reactor coolant system pressure and a low subcooling margin, and that therefore, in those cases, the reactor coolant pump would be tripped even after installation of the automatic pump trip circuits. Is that correct?

MR. BAXTER: Objection, Mr. Chairman. The only matter that was left pending for UCS's cross examination overnight on the answers to Board questions relating to UCS Contention 8 was to review one procedure. My redirect this morning did not cover the subject matter of this question.

CHAIRMAN SMITH: I am going to need the question back. My attention was diverted. Can you give me the question back?

MS. WEISS: When the Board listens to the question back, we intend to relate it directly to Question 1202-6B.

CHAIRMAN SMITH: Does that change your objection?

MR. BAXTER: No, procedure 1202-4 was the procedure they were reviewing overnight.

CHAIRMAN SMITH: Well does that --

MR. POLLARD: It is 1202-4, 1202-6A and 1202-6B were what the witness told us were the procedures he used as the basis for his testimony.

MR. BAXTER: But 1202-4 was the only one you didn't have and therefore requested the opportunity over

night to look at and examine that.

MS. WEISS: We needed to look at them in order to question on all of them. We did no questioning on any of the procedures. We saved it until we could look at all of them overnight. We did not have 1202-4.

CHAIRMAN SMITH: Let's hear the question.

(The Reporter read the pending question.)

CHAIRMAN SMITH: And that is the answer that you received yesterday.

MS. WEISS: We are just asking the witness to verify that that was his answer, and then we are going to ask him a question with respect to what is called for in 1202-6B which is one of the procedures he came back after the break yesterday and said he had consulted.

CHAIRMAN SMITH: So the objection then is perhaps premature. It is clearly what he said. I was reading it. So now let's go to the next question and see -- but would you explain? Your point is you had two of the three procedures, and you didn't for some reasons that are not apparent in the record, you did not elect to examine on those procedures until you had three in your possession?

MS. WEISS: No. Mr. Chairman, let me just backtrack.

The witness came back after a break yesterday afternoon, said he had consulted three procedures, 1202-4,

1202-6A, 1202-6B, and proceeded to give an answer based on his consultation during the break. We did not have 1202-4, nor did we have the other two there with us at the moment.

He remembered that we reserved questioning on all of the procedures. We then went on to another line of questions, and it was said that we would come back here in the morning and question on the procedures, and we read them all over again with reference to his specific testimony yesterday.

MR. BAXTER: Mr. Chairman, Procedure 1202-6B is UCS Exhibit No. 6.

MS. WEISS: Tom, I said we didn't have it immediately before us yesterday.

CHAIRMAN SMITH: The transcript indicated earlier in the day they asked that the procedures be produced for the next day. The missing procedure was produced at the very end of the day. Ms. Weiss at 5275 apparently had forgotten that. Well, I guess not. You had concluded all of your examination for last night, and then you requested -- on 5275 Ms. Weiss says, "Thank you, gentlemen. Those are all the questions we have for you at this time." All right, that is consistent with what her position is now.

And then Mr. Baxter came back at 5275 --

MS. WEISS: Let me direct the Board's attention to on 5276, line 10, the witness begins to mention the three

procedures. I say on line 21, we would like to take a look at those, either now or overnight. We have 6B. I don't think we have either of the other two. The Chairman says why don't you do it overnight, and we can proceed then with the examination.

CHAIRMAN SMITH: But you had earlier in the dasy requested that the procedures be produced.

MS. WEISS: No, not until right there.

CHAIRMAN SMITH: I remember another episode, and my memory is rather definite on it, whatever it is.

MS. WEISS: You are remembering now at the very end of the day, on page 5286 of the transcript, we said we were willing to go forward if we were given five minutes, and the parties agreed that they would rather have it -- if we are cut off from this --

CHAIRMAN SMITH: Ms. Weiss, the difficulty is every time I start to read what you say you said, you interrupt me to tell me what you say you said, and I have to start again.

Now, just give me a moment.

(Pause)

CHAIRMAN SMITH: The ruling is that you may examine on all of the procedures.

In explaining that ruling, we note that in response to a question at TR 5247 and 5248, Mr. Broughton

had indicated that before he could respond to examination, he would have to refer to the procedures. They were provided late in the evening at 5275 and '76. Ms. Weiss is correct, she did request time to examine all of them. As a matter of fact, my memory is it was at the Board's suggestion that the process take overnight and that she not proceed with any of the examination at that time.

MR. CUTCHIN: Mr. Chairman?

CHAIRMAN SMITH: Mr. Cutchin?

MR. CUTCHIN: May I interrupt for a moment to seek some clarification?

Could we get a feel for how much longer this might go and where a good break point would be, because we have scheduling problems with the two witnesses.

CHAIRMAN SMITH: Exactly right. I myself am surprised at the extent of the examination on this point. I cannot point to any concrete thing that indicated that it would be rather short, but I think the general impression was this would be a very brief interlude, something that might even have been completed last night.

MS. WEISS: I think we only have a couple more questions. I'd say five to ten more minutes.

MR. CUTCHIN: Thank you.

BY MR. POLLARD: (Resuming)

Q We have already drawn your attention to page 5247,

and you have read that, is that correct?

A (WITNESS BROUGHTON) Yes, I have.

Q Could I draw your attention now to Emergency Procedure 1202-6B, the note immediately following Step B-7 oni page 3.

A (WITNESS BROUGHTON) I have that in front of me.

Q Is it correct that that note says "some subcooling will be maintained," and that means in the primary system, "unless pressurizer level is lost." Are those the accidents that you were referring to in your answer on page 5247, that is, only those accidents which result in loss of pressurizer level.

A (WITNESS BROUGHTON) In my answer on 5247 I was not discussing all conditions under which an overcooling event might also result in loss of subcooling. I know of some overcooling events which would result in the loss of subcooling. For example, a very large break in the steam line would result in saturated conditions in the reactor coolant system. I am not sure for all of those scenarios what the response of the pressurizer level instrument would be.

Q If you read the entire note that is in Emergency Procecure 1202-6B on page 3, would you agree that that note indicates that the only accidents for which you would lose subcooling would be those accidents where you were not able

to maintain pressurizer level?

A (WITNESS BROUGHTON) For non-LOCA overcooling events. That is what the note says.

Q Thank you.

My last two questions deal on page 5190 of the transcript. At line 13 you were asked, I believe, by Mr. Cutchin, "And in that circumstance, the concern for core damage would be greater than the concern for subcooling or maintaining the 50 degree subcooling?"

MR. CUTCHIN: Mr. Chairman, I believe that is a misprint. My question, if I recollect it, is is the concern for reactor vessel damage greater than the concern for subcooling or maintaining the 50 degree margin.

MR. POLLARD: Mr. Chairman, that is my recollection also.

CHAIRMAN SMITH: Let's change it, then, at page 5190, line 13, we will delete the word "core" and put "pressure vessel," "reactor vessel."

Which do you prefer?

MR. CUTCHIN: "Reactor pressure vessel."

BY MR. POLLARD: (Resuming)

Q So now the question reads, "And in that circumstance, the concern for reactor pressure vessel damage would be greater than the concern for subcooling or maintaining the 50 degree subcooling." Your answer was yes,

and then you went on to explain it.

If I could first focus on the yes part of your answer, what you specifically mean by yes is that even if there were not adequate subcooling, that you believe that the operators should throttle high pressure injection flow for the purpose of preventing damage to the reactor pressure vessel.

Is that correct?

A (WITNESS BROUGHTON) Yes.

Q I would like to contrast that if I could, please, with Step 12 of Emergency Procedure 1202-6B, which begins oni page 7 and continues on page 8. The entire step reads -- and by the way I am reading here from Revision 3 and not 4, so there may be some differences -- "When the 50 degree subcooled margin is established, the RCS pressure/downcomer temperature shall be kept in the acceptable region at figure 2. HPI flow may be throttled to achieve an acceptable pressure/temperature combination while maintaining a 50 degree subcooled margin. Full high pressure injection flow shall be reinitiated if the 50 degree subcooled margin cannot be maintained."

My question is, does that last sentence in this procedure contradict your answer to Mr. Cutchin in the sense that without regard to the pressure/temperature limits, he should reinitiate high pressure injection if he cannot

maintain 50 degree subcooling?

A (WITNESS BROUGHTON) With reference to the more general question that I was answering for Mr. Cutchin, that is, is it more desirable to maintain a 50 degree subcooling or to adhere to the vessel pressure/temperature limits, I believe that -- I still maintain, yes, it is more desirable to maintain the vessel pressure limits, specifically at TMI 1 because we have a very low flux on the vessel. That pressure/temperature limit is so low, it is not very restrictive, and it allows us to meet both of those requirements. It may be that sometime in the future when the vessel pressure/temperature limit changes, we would not be able to meet both of those requirements.

Q We are going to get to the second part of your answer, but for now, would you agree that Emergency Procedure 1202-6B, as written could lead the operator to conclude that the 50 degree subcooled margin is more important than maintaining the pressure/temperature relationship on Figure 2?

MR. BAXTER: Just as a point of clarification for my benefit, I assume that since we are talking about a small break LOCA procedure, that the question pertains to the importance to the operator in a small break LOCA situation.

WITNESS BROUGHTON: I think the way that that page is worded there, it may not be clear which of the two

criteria is more important.

CHAIRMAN SMITH: I think it is time to have a realist c appraisal of how long this examination is going to be. You came up with exactly the answer you were seeking. You said there were two more questions, and now you are going on. I mean, if you have a lot of examination, we will accommodate it, but let's do it. Let's make it realistic.

Could you have done any better on that?

MS. WEISS: No.

CHAIRMAN SMITH: All right. Then you said you had two remaining questions. You asked your two questions. Now you are embarking on another.

MR. POLLARD: In the future I will try and say I have a few more questions. I'm sorry.

CHAIRMAN SMITH: Well, give us an idea.

MR. POLLARD: I have at this point one more question, assuming that the answer doesn't produce another question.

CHAIRMAN SMITH: All right. Then let's evaluate this. You are going to have to have some redirect I would imagine, or do you.

MR. BAXTER: I have identified one question.

CHAIRMAN SMITH: One question.

How about you, Mr. Cutchin? What will be your position, do you know?

MR. ROBERT ADLER: I have one quick question.

BY MR. POLLARD. (Resuming)

Q In the second part of your answer, on page 5190, you said that because of the age of the vessel, that it is likely that both of these concerns can be met.

Can you explain what will happen as the vessel ages and which of those concerns will be more important as the vessel ages?

A (WITNESS BROUGHTON) As the vessel ages, the pressure that you would be allowed to take the vessel to for a given temperature will decrease, and if that is the case, then it may not be possible to meet both the pressure/temperature curve for the vessel and the 50 degree subcooling margin. My understanding is if that case arises over the life of the plant, then it becomes more important to meet the pressure/temperature margin than the 50 degree subcooling margin.

MS. WEISS: At this time UCS would like to have marked for evidence Procedure labeled Three Mile Island Nuclear Station Unit 1 Emergency Procedure 1202-4, Reactor Trip. Note at the top, 1202-4 Revision 17, 8/27/80, and I believe that would be UCS 9. Is that correct?

CHAIRMAN SMITH: I have seven. I don't know what 7 and 8. Perhaps I overlooked them.

MS. WEISS: This will be marked as UCS 7.

CHAIRMAN SMITH: All right.

Now, you never did -- last night you were --

MS. WEISS: We never moved NUREG-0560.

CHAIRMAN SMITH: You never identified it?

MS. WEISS: No.

CHAIRMAN SMITH: Then we are at No. 7.

(The document referred to was marked UCS Exhibit No. 7 for identification.)

MS. WEISS: 1202-4 is 7, and the procudure entitled Three Mile Island Nuclear Station Unit 1, Emergency Procedure EP 1202-6A, Loss of Reactor Coolant/Reactor Coolant Pressure within Capability of Make-up System (RC Pressure Above ESAS Set Point), marked at the top 1202-6A, Revision 4, 8/9/80, and we would like that to be marked as ECS Exhibit 8.

(The document referred to was marked UCS Exhibit No. 8 for identification.)

MS. WEISS: And I move them both into evidence at this time.

CHAIRMAN SMITH: Any objections?

MR. BAXTER: No objections.

MR. CUTCHIN: No objection.

CHAIRMAN SMITH: Exhibit received.

(The documents referred to, previously marked for identification as UCS Exhibit Nos. 7 and 8, were received in evidence.)

MS. WEISS: Mr. Chairman, we have not has a chance to make the copies of these. We will endeavor to make those, and I will supply them to the reporter and copies to the Board.

CHAIRMAN SMITH: Very good.

I think our procedure should be that you end up the questioning.

MR. BAXTER: Excuse me?

CHAIRMAN SMITH: You can ask your redirect at the end I think is a better procedure.

Mr. Cutchin?

MR. CUTCHIN: No questions.

CHAIRMAN SMITH: Mr. Adler?

BY MR. ROBERT ADLER:

Q Mr. Broughton, am I correct that automatic trip of the reactor coolant pumps is a long term requirement of I&E Bulletin 79-05C?

A (WITNESS BROUGHTON) I believe it is a long term requirement. I am not sure of the exact source of that.

Q Okay. Can you tell me your schedule for

implementation of that requirement?

A (WITNESS BROUGHTON) I do not know what our current engineering schedule is for that.

Q Do you know at all what is involved in implementing that requirement?

A (WITNESS BROUGHTON) To implement the requirement certainly requires logic, electrical logic system. It may require new sensors to sense conditions in the system to be used in the logic network, and it may also require changes in components that actually cause the breakers on the coolant pumps to open. I don't know specifically which pieces would require to be provided new and which are existing components in the plant.

Q I am really trying to determine the feasibility of implementing that requirement prior to restart.

A I am not able to comment on how feasible that is.

MR. ROBERT ADLER: Thank you.

CHAIRMAN SMITH: Mr. Baxter?

FURTHER REDIRECT EXAMINATION

BY MR. BAXTER:

Q Mr. Jones, Mr. Broughton was asked this morning by Mr. Pollard about a situation where, as reactor coolant system pressure approaches 1600 psi, the reactor operator manually actuates high pressure injection such that we never get to the situation where he would be called upon to trip

the reactor coolant pumps. Is this an unsafe condition?

A (WITNESS JONES) No, it is not, and the reason for that is the saturation temperature or the saturation pressure in the system during the LOCA would be at a pressure of approximately 1400 psi. So if the operator could, did in fact actuate a second make-up pump or actuated a pump in the HPI mode and held system pressure or even caused it to repressurize, he would have a solid, water solid system, and operation of the reactor coolant pump in that mode is not unacceptable. It is a very safe condition.

Additionally, the breaks that are in the window or the area where there are concerns about running the reactor coolant pumps are breaks of .025 square feet and larger. Those breaks could not be handled by actuation of the make-up pumps to hold system pressure above 1600 pounds.

MR. BAXTER: That's it.

CHAIRMAN SMITH: All right.

Gentlemen, you are excused. Thank you.

(The Witnesses were excused.)

CHAIRMAN SMITH: I guess we ought to have a short break and then begin with your witnesses.

MR. CUTCHIN: Fine. I guess we ought to point out if they wish to get them at the break, our witnesses will be referring to the three-volume Rogovin report, and to the orange, thick volume NUREG-0600.

CHAIRMAN SMITH: Okay. What is the problem. You have one witness that has to --

MR. CUTCHIN: The witness, Mr. Martin, who came up from Region 2 in Atlanta, has a need to get away by this evening. So if we could -- I have no feel for how long the Board and the parties may wish to have them.

CHAIRMAN SMITH: All right.

(A brief recess was taken.)

CHAIRMAN SMITH: Gentlemen, may I administer the witnesses' oath, please.

Would you stand?

MS. WEISS: Mr. Chairman, at this time I would like to note my objection for the record to the introduction of the live testimony of these two witnesses with virtually no notice to testify on Contentions which were made and specified by UCS over one year ago, and to their use also without notice of documents literally hundreds of pages long which we have had no opportunity to specifically review for purposes of their testimony. I believe it is unfair. I believe it violates the spirit at least of the Commission's regulations, particularly 2.743(b), and we believe it is an infringement on our right of due process.

CHAIRMAN SMITH: Would you please in your objection address the aspects of the Board's discussion as to how due process might be preserved that you feel is

inadequate.

MS. WEISS: We understand that the Board has told us they would entertain motions to recall these witnesses. However, we are under an obligation day after day to prepare for extensive cross examinatin on the order of the Contentions as specified, and this places an additional and onerous burden on us to go back and review all of this testimony after it has been completed, work it in somewhere. It places a burden on us to move that they reappear for specific reasons. We think it is an unreasonable burden given that the justification for it is the convenience of staff witnesses who can presumably be ordered to appear at any time.

CHAIRMAN SMITH: Well at the end of their testimony you are going to have in question and answer form their testimony as if you would have it written. I am trying to understand what we could do other than not hearing from these witnesses at all that would satisfy your concerns.

MS. WEISS: I would like to hear from these witnesses, I would like to see their testimony in written form with some notice to us. I would just like to stress to the Board, we have received some testimony from the staff which has dribbled in. It was not in on the dates previously decided, which had given us less than 15 days notice, and which we have not objected to because we feel

that we have been able to get ready for it, but our honest feeling is that this is an onerous burden on us, and we believe that they have all of the resources available. They have had this Contention for a year, they have known exactly what we were getting at. They did extensive discovery of us. They had the time to get it ready in writing, and if they didn't do it, I won't object to them doing it now, but I will object to them burdening us by doing it live.

CHAIRMAN SMITH: And you see no distinction in the Board's producing the witnesses because of the Board's concern compared to producing them as far as a party in the proceeding is concerned?

MS. WEISS: I'm sorry, I didn't understand that.

CHAIRMAN SMITH: These witnesses are here in response to the Board's concerns in questioning the scope of the previous witnesses' testimony. Can you distinguish in that situation?

MS. WEISS: Well, I think that they are primarily here because the questions that they were asked came directly from and derived directly out of UCS Contentions 1 and 2.

Now, the Board has performed the function of elaborating on those, and I think that that has been a useful and a valuable function for purposes of the record, but they are primarily here to respond to a UCS Contention

which they have known the bases of and the specifics of for a year. I understand the Board's desire to have this testimony on the record at this time. I think, however, that it -- my view is that it is overridden.

CHAIRMAN SMITH: Well, the Board observed ideally it would have been better to have the opportunity for written testimony and an opportunity to study it, but the Board feels they want to have this explanation and this background presented to them so we can better understand the proceeding as it goes along.

Your objection is overruled. However, you should remain sensitive to your opportunity to seek specific relief.

Mr. Cutchin.

MR. CUTCHIN: Thank you, Mr. Chairman.

I would also like to note for the record as well that it is the staff's view that its testimony on the UCS 1 and 2 was sufficient to address the Contention. We made these witnesses available, as the Board noted, to respond to detailed questions that the Board had about what happened at TMI 2, and that is the purpose for bringing these witnesses here.

I would first like to put into perspective what they are here for, and then ask them a few questions to introduce their professional qualifications and so forth.

I have passed out to the Board and the parties

earlier this morning copies of the professional qualifications of both Mr. Martin and Mr. Johnston. Mr. Martin, as his qualifications reflect, was the team leader of the investigation of the operational aspects of the accident that occured at TMI 2 on March 28, 1979. That investigation resulted in the preparation and issuance of the document known as NUREG-0600.

Mr. Johnston was the task leader for the reactor plant performance on the NRC special inquiry group which is otherwise commonly known as the Rogovin group. His work assignment in that connection included developing a description of the accident sequence, evaluating plant performance and core damage, and assessing alternate accident sequences and human factors influences on the accident.

Mr. Johnston is available to describe the sequence of events that occurred at TMI 2 from just before until about 16 hours after the events initiating the accident. He is prepared to do that by breaking the accident scenario into phases and explaining when and why that group believed core damage and hydrogen generation occurred, whether and if so how the capability to cool the core was affected by core geometry changes and the hydrogen generated by metal water reaction, what was done to re-establish effective core cooling, and when and how natural circulation was

established and b ame effective in cooling the core. And in doing so, he can discuss the amounts of hydrogen that were generated, and that was a concern which I believe the Board had the other day.

Mr. Martin is prepared to respond to questions about what happened in the accident sequence.

Whereupon,

WILLIAM V. JOHNSTON and ROBERT D. MARTIN,

called as witnesses by counsel for Nuclear Regulatory Commission Staff, having first been duly sworn by the Chairman, were examined and testified as follows:

DIRECT EXAMINATION

BY MR. CUTCHIN:

Q With that introduction, Mr. Martin, you have before you a copy of the document labeled Professional Qualifications, Robert D. Martin.

A (WITNESS MARTIN) That is correct.

Q Does that accurately reflect your education and experience which qualifies you to testify on these subjects in this proceeding?

A (WITNESS MARTIN) Yes, it does.

Q Mr. Johnston, you have before you a document labeled Personal Qualifications of William V. Johnston dated November 1980. Does that accxuiately reflect your professional qualifications which you believe qualify you to

testify in this proceeding?

A (WITNESS JOHNSTON) Yes, I believe it does.

Q Gentlemen, do you adopt this as your written direct testimony in this proceeding?

A (WITNESS JOHNSTON) Yes.

A (WITNESS MARTIN) Yes.

MR. CUTCHIN: Mr. Chairman, I ask that these two documents be received into evidence and bound into the transcript at this point as if read.

CHAIRMAN SMITH: Without objection, they will be so received.

(The written direct testimony of William V. Johnston and Robert D. Martin follows:)

(2)

PERSONAL QUALIFICATIONS

WILLIAM V. JOHNSTON

NOVEMBER 1980

I am presently employed by the U. S. Nuclear Regulatory Commission, within the Office of Nuclear Reactor Regulation as the Chief of the Core Performance Branch of the Division of Systems Integration. My work address is 7900 Norfolk Ave., Bethesda, MD. My functional assignments include review and evaluation of the nuclear, thermal, hydraulic and reactor fuel aspects of nuclear reactor design and performance.

Previously, (10/73 to 6/80) I served as Chief of the Fuel Behavior Research Branch in the Reactor Safety Research Division of NRC's Office of Research. This included managing research programs concerning fuel assembly response during normal, abnormal and accident conditions. From May 1979 to February 1980 I was on special assignment to the NRC Special Inquiry Group (commonly known as the Rogavin Group) as the Task Leader for Reactor Plant Performance. This work assignment included developing a description of the accident sequence, evaluating the plant behavior and core damage, assessing alternate accident sequences and human factors influences on the accident.

Before this assignment I served about 1½ years as a nuclear engineer in the Reactor Development and Technology Division of the AEC on LMFBR fuels technology.

Prior to joining the NRC (then AEC) I worked for Rockwell International in their Rocketdyne, Science Center and Atomics International Divisions for a total of 11 years in research management positions related to materials science, and nuclear fuel.

I also worked as a Research Associate at the Knolls Atomic Power Laboratory in Schemertady, New York on nuclear fuels problems related to Naval Reactors.

I have degrees in Chemistry (B.A. 1950), Physical Chemistry (PhD. 1955) and am a registered PE in Metallurgy in California since 1967.

(1)

PROFESSIONAL QUALIFICATIONS

ROBERT D. MARTIN

I am presently the Chief of Reactor Projects Section No. 2 in the USNRC Region II Office in Atlanta, Georgia.

I obtained a Bachelor of Science degree in Mechanical Engineering from the Polytechnic Institute of Brooklyn in 1957 and a Master of Science degree in Nuclear Engineering and Professional Engineer (Nuclear Engineering) from the University of Michigan in 1967 and 1973 respectively.

From 1957 to 1964 I worked for Union Carbide Corporation at the Oak Ridge National Laboratory and their Tuxedo, New York research center. From 1964 to 1974 I was at the University of Michigan as the manager of their research reactor. From 1972 to 1974 I was also a part time lecturer in the Department of Nuclear Engineering teaching a course in power plant operation. In addition, from 1970 to 1974, I was a consultant examiner to the Operator Licensing Branch of the AEC.

In 1974, I joined the AEC as an inspector in Region III (Chicago, Ill.), and I was the project inspector for Davis-Besse 1. In 1977, I was transferred to Region II (Atlanta, Ga.) where I was assigned as Chief of the Nuclear Support Section. In April 1979, I was assigned to be the team leader of the OIE investigation into the operational aspects of the accident at TMI-2. In August 1979, when completing that assignment, I assumed my present duties as a Project Section Chief.

MR. CUTCHIN: Now, we can proceed as follows, Mr. Chairman. I can either propose these questions that I described that the witnesses, that particularly Mr. Johnston is prepared to address, or what I think would perhaps be more efficient is to have him go through a hopefully brief narrative explanation breaking down the scenario in the fashion that I previously described.

CHAIRMAN SMITH: Are there any objections if he goes through in a narrative fashion which I think I agree would be the most efficient. However, we have the problem there that there is no opportunity for objections. The answer is in, but I don't believe that testimony of this nature is a particular problem. The relief can be a request to have the answer struck. So I think that would be more efficient.

Are there any objections to that?

MR. BAXTER: We have no objections.

MS. WEISS: May I ask if they are referring to some specific accident scenario as a reference for the testimony he is about to give?

MR. CUTCHIN: Mr. Johnston will be referring to various graphs in the so-called Rogovin report, which the Board and the parties were provided copies of sometime in the past.

MS. WEISS: If he would identify which those are,

I would have no objection then.

MR. CUTCHIN: He will do so as he refers to them one by one at the time he refers to the documents. They will not be to the whole series of documents. He will refer to specific figures and graphs in explaining questions perhaps, and I have asked him to clearly identify which figure number, which volume, and which particular line on a graph he is referring to.

CHAIRMAN SMITH: It is going to take some cooperation and a little bit of work to proceed in this way and still give an opportunity for any party to make objections or advance motions to strike, but I think that is fine.

MS. WEISS: Before he starts, we have some of the volumes of Rogovin with us, but we don't have all. So if he could tell us in advance what volumes he is going to be referring to.

MR. CUTCHIN: Can you do that, Mr. Johnston?

WITNESS JOHNSTON: Yes. I will do that now before I start.

I am planning to use portions of Volume 2, Part 2 of the special investigation report. In particular, I am going to be dealing with color plate No. 3, which is entitled "Plot of System Parameters for the First 16 Hours of the TMI 2 Accident," which is located following page 492

in that volume, in that Part 2 of Volume 2.

I may refer to other portions of the volume, and I will simply mention briefly that the narrative description of the sequence of physical events is found starting on page 309 of that volume, and more directly, Section C entitled "Plant Behavior in Core Damage," which begins on page 447 and following on to page 535 is the principal area that I may make reference to. However, I expect principally to refer only to this color plate which I mentioned first.

BY MR. CUTCHIN: (Resuming)

Q Mr. Johnston, would you please try to arrange the microphone so it is close enough to your lips so that everyone can hear.

A (WITNESS JOHNSTON) Sure.

Q Then would you proceed, Mr. Johnston, to describe the sequence of events that occurred at TMI 2 on March 28, '79, and break the scenario into the various phases as you go through your explanation.

A (WITNESS JOHNSTON) All right. We will begin just prior to 4:00 o'clock in the morning on March 28. The reactor was operating in a normal manner at about 97 percent power. At approximately that time there was a transient, there was an event which occurred in the secondary side of the plant which, without going into a great amount of detail, simply resulted in a turbine trip, and the plant

then began to go through the normal sequence of events following a turbine trip.

During this period there was a rise in pressure which resulted in an opening of the pilot operated relief valve, which was the normal occurrence during this type of plant response. However, when the pressure began to drop back toward the set point of the valve, instead of closing as it normally did, the valve remained opened. The valve remained open for some time following that, and was subsequently closed at a later time, which I will mention later.

Following this valve remaining open, there began to be some anomalies in some of the plant parameters, in particular, the pressure continued to fall, and the pressurizer level continued to rise. The high pressure injection system was on at this time, and the reactors, as the pressurizer level began to rise, began to cut back on that system because the pressurizer level was approaching the top. In a sense this is what continued for some period of time. Basically the system was losing coolant out of the open PORV, and the core was gradually depleting.

From a point of view of core damage, there was very little that happened of interest to us in roughly the first hour. If one refers to the chart, Color Plate 3, there were two things that might be noticed. The first is

that the pressure was dropping, and that is indicated in the middle of the page. It is called Primary System Pressures, and on this chart there are a series of red vertical lines, once each hour. And you will note during the first hour that there was a drop in the primary coolant pressure from 2000 down to the order of around 1200 psi, and it more or less leveled out in that time period.

The primary coolant pumps were both working at this time. There were flow indications which were recorded on the reactivitor at the plant which showed later on that there was a reduction in the mass flow. If you refer to the chart that I am using, the evidence that has been deduced since that time to indicate that there is loss of mass was the red line on the chart which is called Source Range Monitor, again located right next to the primary system pressure on the chart, and you will see that in the first two hours that it initially dropped and then slowly began to rise, and you see that the tracing shows some jiggles and some uncertainties. This was interpreted at the time, because this is a neutron source range monitor, that there was some increase in the number of neutrons in the system.

However, during our analysis, the conclusions were drawn that we are really talking about a reduction in the density of water inside the core and in particular in the downcomer region which is between the core and the outside

of the vessel, which serves as a sort of a shield. If there is water there you will get fewer neutronic counts, but if the density of water that is in that space is becoming less and less, then you will see an increase in that region, and that is what the evidence shows.

The operators are also receiving evidence at this time that the pumps were beginning to vibrate excessively, and as a consequence of that and because of procedures which they had, they shut off first the B pump at approximately 73 minutes, and then at about 100 minutes, the second reactor coolant pump was shut off.

Although the estimates have varied as to how much water was lost from the core up until the time that the second pump was shut off, there is general agreement that about two-thirds of the coolant had been lost from the primary system by this time. In other words, in about an hour and 40 minutes there was about 60 percent of the water lost.

The core was nevertheless being adequately cooled during this time. There is two strings of evidence for that. If you refer to the next series of curves on our chart that show primary system temperatures, you will see tha for the first hour and three-quarters, all of the lines coincide. Those lines are showing the temperatures of the hot legs and the cold legs, as we call them, on the plant,

and what you see is that they are substantially the same, and that is one indication that there is no inadequate cooling in the core at that time.

Secondly, there was no radioactive release from the primary system nor was there any indication of this in the detector, in the radiation detectors located which had a view of some of the primary system piping in the plant.

However, following -- and I would say that is, I would call that Part 1 of this thing, namely, in the first hour and a half there was no damage to the core, even though the pumps were circulating a mixture of water and steam, a two-phase mixture, the core was adequately cooled. However, at this point, when the second pump was shut off, the water level in the system then sought its level, and the water level was about one to two feet above the top of the core at that time.

Because the B pump had been shut off first, there was an accumulation of water in that pump relative to what was in the A system, and as a consequence, the B pump was probably full of water to roughly the same level, and if I could refer to the chart behind me, I think I might facilitate the discussion.

If we call this the B steam generator and this the A, the pump was shut off first here, and then finally this one was shut off. Now, the reason the vibration became

excessive is because the water did not have any -- I'm sorry, the pump wasn't drawing any water to pump into the core. When the pump was shut off, the water level in the system fell to about this level as far as the core is concerned. On the B side the water level was probably about at this height. However, because the A side had been pumping and nothing had been coming back, it was depleted on this side, and the water level was therefore lower. The pressurizer is full.

MR. CUTCHIN: Mr. Johnston, when you refer to this level, could you relate that to a core height or some other level which would make sense to the record?

A (WITNESS JOHNSTON) I'm sorry. Yes. The level in the B steam generator both within the steam generator itself and in the cold leg which leads into the reactor vessel were approximately the same height as the water in the reactor vessel itself, and just as I say, a foot or two above the top of the core. The A steam generator was depleted of water, and the water level would be essentially at the bottom of the steam generator and partway up the cold leg leading to the reactor coolant pump.

In this period of time now that I am beginning to speak about, this was the period when the damage began to happen to the core. This runs from the time period of approximately one hour and 40 minutes to approximately two

hours and 54 minutes. During this time period -- well, during the initial portion of this time period, the PORV was open, the coolant was -- had reached saturation temperature and was boiling in the sense that there was a boildown of the coolant from starting, as I say, about a foot above the top of the core and gradually dropping down then and exposing portions of the core as it proceeded.

The rate of coolant level drop was of the order of about a foot every four minutes, according to estimates which we made in our study. It was not until the core was uncovered, of course, that there began to be an increase in temperature of the exposed portions of the fuel rod. In fact, there is not an immediate rise in temperature of the exposed fuel rods because there is both a heat source and a heat sink operating, namely, the steam which is being produced by the water boiling is also passing up past the surfaces of the fuel and is giving some added cooling. So there is a delay between the time the fuel was exposed, the time the cladding is exposed, and the time it begins to heat up.

The coolant continued to boil away, according to our estimates, until the level reached about seven to eight feet down from the top of the core, which says that about three or four feet remained covered during this time period.

Evidence that we obtained which supported this

came principally from analytical calculations which were made utilizing the decay heat that was available at the time, the boil-off rate, things of that sort. And in addition, there was experimental data that was available from the indications of the self-powered neutron detectors, which are located in strings, roughly seven of them about a little over a foot apart, within the center of the fuel assemblies in this plant, and they had a particular characteristic of as they became hot, they would go off scale on the strip chart that was indicating at the plant, and by analysis that was done afterwards, we have some general way of following the times at which the various elevations went off scale, and through the knowledge that some of them never went off scale or went off scale briefly at certain times, we have an idea of how far down the water level probably reached.

The pressure in the primary system was continuing to drop during most of this time before the PORV was closed. However, shortly before that time the evidence is that the pressure began to rise in the system even though the PORV was closed. At the time the PORV was closed, which was about two hours --

MS. WEISS: A point of clarification. Just for clarification, did you mean that the pressurizer system started to rise before the PORV was closed?

WITNESS JOHNSTON: The pressure in the primary system began to rise before the PORV was closed.

MS. WEISS: Was closed.

WITNESS JOHNSTON: That's correct. The PORV was closed shortly after two hours, and the system pressure then began to rise more rapidly. It was during this period of time that the core heat-up was taking place. We have presented in the report on another page, if I may refer to them, some figures of our estimated or our calculated rates of heat-up of the core.

If you turn to pages 514 and 515 of this document, you see an example of the types of calculations which were made as a part of our study and which are similar to calculations that were made by other groups going through similar developments of sequences.

What you see on there, Figure 2-30 is entitled "Fuel Temperature Histories," and it is a plot in one axis of the calculated temperature of the cladding as a function of time with Time Zero being the time at which the second reactor coolant pump was turned off. These curves are the general -- I should say the curves have numbers on them going from zero to 7. Those correspond to elevations of the core with zero being the top of the core and 2 being two feet down from the top, 3 being three feet down from the top and so forth.

A series of -- what that calculation or what the data, what the curve shows is that after an initial induction period of somewhere in the neighborhood of 16 minutes on the figure 2-30, then there is a more rapid increase in the cladding temperatures indicating first that the highest level of the core gets hot. The indication on here is that upper portions of the core reached temperatures of the order of 3000 to 4000 degrees Farenheit and then began to cool down.

DR. JORDAN: At what time in absolute -- at what time is time zero? You say that is when the pump was turned off?

WITNESS JOHNSTON: That is when the second reactor coolant pump was turned off.

DR. JORDAN: At what time is that?

WITNESS JOHNSTON: A hundred minutes into the accident.

DR. JORDAN: A hundred minutes?

WITNESS JOHNSTON: Yes. And it was following that, you see, that the water began to boil down and uncover the core for the first time. And I suggested that it dropped on the average of about a foot every four minutes.

So you see an induction period, and then the cladding begins to heat up at abouit 1500 F, which would correspond to the about 20 minutes. We would predict or we

do predict that cladding rupture began, but oxidation of the cladding or the metal water reaction which produces hydrogen wouldn't begin until about 1800 degrees F was reached, which took in the neighborhood in this chart of about 24 minutes.

We did this, made similar calculations for various peaking factors across the radius of the core so that you will see on the code at the right on the table RPF 1.467 on the figures that you have. That is the region in the center of the core with the radial peaking factor of 1.4, and as you move across the core, the radial peaking factor drops to a low of I think it is .9.

By doing a set of calculations of this sort, you can arrive at a picture of the times at which various temperatures were reached in the core, an estimate of what fraction of the fuel rods reached temperatures at which oxidation would occur, and by combining this kind of information, you can arrive at an estimation of how much hydrogen was produced and what kinds of time periods the core was subjected to extreme temperatures.

This type of core heat-up was continuing, as I said, until roughly two hours and 54 minutes.

DR. JORDAN: May I ask one question at this time?

Is it your understanding, then, that up to the time at which the coolant pumps were turned off, there was a two-phase mixture being circulated through the core?

WITNESS JOHNSTON: That is correct. The pump was on and it was circulating a mixture that was increasingly carrying less water and more gas, more steam phase.

DR. JORDAN: Yes. But as soon as the pumpts were turned off, the boiler condenser phase was not adequate to --

WITNESS JOHNSTON: That is correct, and the reason natural circulation was not effective at that particular time was because in order to have -- there was certainly the boiling, and certainly at this time there was some refluxing taking place. However, because the coolant in the A steam generator, as I mentioned, was very low, not sufficient water accumulated in it to give you the siphon effect, not siphon but to force water back into the core, so that even though there probably was some condensation taking place because there was water on the secondary side of the steam generators, it didn't have enough volume to fill up the cold leg and get back into the core.

DR. JORDAN: But I guess I don't see why it needs to get back if there are still several feet of water in the core.

WITNESS JOHNSTON: Well, it was boiling away, as I said, at a foot every four minutes.

DR. JORDAN: A foot every four minutes.

WITNESS JOHNSTON: Yes.

DR. JORDAN: So therefore you say even the bottom

of the core became uncovered soon.

WITNESS JOHNSTON: No, it never went all the way to the bottom of the core. It never went below in the neighborhood of about three feet from the bottom. The upper portion of the core was exposed.

DR. JORDAN: All right.

Now then, you are saying that the generation of the steam from the boiling of the bottom three feet of the core, the steam and water particles that would surge up through the core was not adequate to take care of the heat being generated.

Is that your --

WITNESS JOHNSTON: That is correct. Under those conditions, because of the cosine shaped power distribution in the core, when you get down to the lower three feet or so of the core, the decay heat is not great, and it wasn't boiling very much water. As a consequence, the steam flow up past the hot rods was not very great.

DR. JORDAN: I see. Does that mean that during a reflood situation the water has to get considerably higher than three feet before the temperature rise is turned around in the upper part of the core, and I am assuming now the classic loss of coolant accident.

WITNESS JOHNSTON: Not necessarily so in the classic loss of coolant accident. While what I have stated

is correct in this particular situation, in the way we normally analyze the classic loss of coolant accident, the reflood water that is coming in does hit hot surfaces, and there is a lot of splashing and carrying up of spray because the water is coming in very fast and the water level is rising relatively fast, and it is the water dropletsk and so forth that are carried up into the upper portions of the core which provide cooling and ands a rapid turnaround. That would not be the case here. Even if we did have water coming in the cold legs, it would be more of a quiescent flowing in, as you have in a distillation column.

DR. JORDAN: Okay.

WITNESS JOHNSTON: Now, there was a second factor which contributed to the loss of heat transfer in this particular case, too, and that is that when the PORV was closed and the pressure in the system began to rise, that would stop the system from boiling and it would not boil as hard as it had been boiling before. Therefore, again, there was less steam being generated, and until the core -- until the water had heated up again to the saturation pressure at higher temperatures, there would be a reduction in flow. And finally, when it did reach the high pressures, however, because the heat vaporization was becoming smaller as the pressure goes up, for the same amount of heat input you will get more steam formed, and therefore you will get some

enhanced cooling later on. You go through a minimum, and then you get an enhancement, and in one sense that is why the curve that I was referring to a few minutes ago shows that the temperature rise is terminated and it begins to turn over.

Well there are two reasons for that. One of them is the extra heat flow, the extra steam flow. The second reason is much of the driving force for that temperature rise was the metal water reaction, and as you use up the amount of zirconium that is available to react, the heat generation drops off. It means your heat source is dropping off, but your heat sink, your cooling supply is increasing. Therefore you get a turnaround.

MS. WEISS: Can you tell us what time period you were referring to then?

WITNESS JOHNSTON: The period just roughly from two hours and a half to two hours and 54 minutes.

At two hours and 54 minutes, the plant operators started up successfully the reactor coolant pump B, 2B, and it ran according to the record that we obtained from the reactivitor -- I am sorry, it pumped water for the order of about 9 seconds, which would correspond to about a thousand cubic feet of water being transported through the core, and then followed by essentially no water being transported through the core, even though the pump remained on for a

total of 19 minutes.

Evidence for this, of course, was known to the staff at TMI 2 because they observed that the amperage that the pump drew dropped rapidly from 600 down to the order of 100 amps. The flow indicator, which they had in the primary system, merely had one little blip on it, and that was it, but the value of that particular event, however, was that it is the action that terminated the temperature rise and quenched the core because the thousand cubic feet of water that kind of went through as a slug hit the hot fuel surfaces and cooled them down. It also resulted in damage to the core because the metal water reaction which had been taking place had embrittled portions of the core, particularly the top half, and when the cold water hit the hot zirconium dioxide, it fractures it and breaks it, and that resulted in the damage to the core to the extent that it caused some changes in the geometry of the core.

I would say that is the termination of the second period of the event. This is the event, as I say, where the damage occurred to the core. It is where most of the hydrogen was produced. We have estimated that -- may I use a different piece of paper to obtain some estimates of the amount of hydrogen that was produced? It has been copied from the blue book. On the other hand, I can quote direct from the blue book if that is preferable, Mr. Chairman.

BY MR. CUTCHIN: (Resuming)

Q As long as you clearly identify the source of your information.

Are you saying that the figures actually appear in the Rogovin report? If so, would you please identify the location in that document where they appear, and you are using your own shorthand notes which summarize the information that is there?

A (WITNESS JOHNSTON) They are more than notes. They are something I had typed up for a different purpose. I think I can refer to the report.

Q That might be the simplest way to do it for the record. Then everyone would have the same information before them.

A (WITNESS JOHNSTON) Okay. On page 530 of Volume 2, Part 2, there is a section which is called "Hydrogen Accounting." In that section we summarize -- it is on the left hand column and includes the right hand column as well. In that section, I brought together in one place the estimates which we and other investigators have made of the amount of hydrogen which was prodsuced, together with some discussion of the time in the event when it was produced. The units that ar used in this report are all the system international units, so that we are talking kilograms, and if you remember, a kilogram is 2.2 pounds, why we can

perhaps convert it into pounds.

But the summary is that we feel that about 350 kilograms of hydrogen was produced roughly in this first time period that I am speaking about, and that is 700 some pounds.

That hydrogen would have occupied a volume at that temperature -- I'm sorry, at that pressure -- in the neighborhood of 2,000 cubic feet. Yes, that's correct, approximately 2,000 cubic feet.

The total system -- the total volume of the primary system was about 12,000 cubic feet, to give you a perspective. But that is more than sufficient to provide gas phase or noncondensibles. If I may refer to the schematic of the TMI facilities, that would suggest that the regions of the hot leg in the upper portion of the steam generators would have contained the noncondensible gas, as well as the upper portions of the reactor vessel, and possibly some of the upper portions of the two cold legs, which did not contain water at that time in our estimation.

DR. JORDAN: I'm a little puzzled by this, because, are you saying at that time the block valve was closed and the hydrogen was kept inside of the primary system?

WITNESS JOHNSTON: That's correct. The block valve was closed at that time.

DR. JORDAN: I see.

WITNESS JOHNSTON: Now, following this period, the next period, which runs roughly, as I say, from about three hours to approximately five hours, is the period of time in which the plant operators were trying to reduce the

pressure.

DR. JORDAN: Could you wait just a minute. It's after page 490, is it? I found it.

MR. CUTCHIN: After 492.

WITNESS JOHNSTON: After page 492, yes.

DR. JORDAN: Yes.

WITNESS JOHNSTON: As I was saying, roughly the period of time from three hours to approximately a little after five hours into the accident, the plant operating staff was, I believe, attempting to reduce the pressure into the system so that they could get onto one of the decay heat removal systems. And they were basically unsuccessful in accomplishing that during this period.

They knew from testimony which we heard and which was obtained from Mr. Martin's group that they were attempting to get water into the hot legs so that they could start a pump. They knew that the temperatures in the hot legs were high. They were above the saturation temperature. They were in the neighborhood of 700 to 800 degrees F., as indicated by platinum resistance thermometers located near the top of the hot legs.

If you refer to the color plate 3 and look at the second grouping of curves, called primary system temperatures, you will see now that the red and the green line have increased in temperature, having diverted from the

common lines after about two hours, and that the blue lines of the different, the light and dark blue and the pale red, have gone colder.

Those are the cold legs. So that you see a change in the temperatures, with the hot legs going hot and the cold legs going cold. And if you look just in general at the remainder of the time period, the importance is that the hot legs remained high and at elevated temperatures until about ten hours into the accident. Then there began to be some changes.

But for the first -- from roughly two hours until ten hours, you are seeing a great difference in temperature between the hot and the cold legs. And the burden on the operators was to try to reduce that difference.

DR. JORDAN: This means there was a large delta t across the core.

WITNESS JOHNSTON: That is correct.

DR. JORDAN: And perhaps an insignificant flow, therefore.

WITNESS JOHNSTON: An insignificant what?

DR. JORDAN: Flow.

WITNESS JOHNSTON: Very definitely, yes.

During this period that the plant operators were endeavoring to reduce the pressure -- and as I said, they were unsuccessful -- two other things of importance were

happening. The first is that, if you refer all the way up to the top of my color plate 3, where we have the blue lines which indicate when the various makeup pumps were turned on and when the block valve was opened and so forth, the top line shows, the one that is blue, it says that makeup pump 1A was on. And then there are two little blips at the top of that, which corresponds to when the HPI mode was activated on those two pumps -- on that pump.

You will note that at about three hours and 30 minutes, and also at about four hours, there is a blip indicating that makeup pump 1A was on in the HPI mode; and also that makeup pump 1C was also turned on in the HPI mode.

Now, that means that they were putting coolant back into the core in quantity, at least they were attempting to.

DR. JORDAN: Was 1A putting coolant into the core all this period?

WITNESS JOHNSTON: 1A had been on. But because of the ability to throttle when they were not in the HPI mode, they had throttled it back in varying amounts, but basically had throttled it way back and they were putting rather minimal volumes of water in.

The interpretation which we have made of this data, as well as the change in the pressurizer level that

occurs at approximately the same time -- you will note there's an increase and then a dip and then an increase. That is the green line, first line on the chart of the lines. We have concluded from that and other evidence that sufficient water was put into the core at that time to cover the top of the core. In fact, the water level as we have interpreted -- and I will again refer to the chart here. The estimate is that the water was probably up above the core and in this general region here of the hot legs, probably not quite to the surge line of the pressurizer, but almost, give or take a foot or two.

DR. JORDAN: Can you tell us what time?

WITNESS JOHNSTON: That is about three and a half hours into the accident.

Now, although there's been some disagreement over what I want to say next, the consensus of our report and the contractor who supported this was that after four hours the core probably remained covered. There was no further uncovery of the core following this second HPI injection.

Now, I have to make the point that, even though the top of the core -- even though the water level in the system was higher than the top of the core, that is not to infer that all portions of the core was cool. The reason for that is because of the location of the damage to the core.

And during this same time period that I am describing, there were readings being taken on thermocouples which were located just above the top of the core. They were part of this string that contained self-powered neutron detectors. Therefore, they came in from the bottom and passed through the core and just up to the region just above the top of the core would be where the bead of the thermocouple is located. So it is really a core exit thermocouple.

These thermocouples are read out routinely, can be looked at routinely on the plant computer system. However, it is the famous system in which, if it goes above 700 degrees F., it prints question marks because it was only programmed to go to 700 degrees F.

In addition to that, however, in the time period between four and five hours there were readings made in the cable room under the control room in which they read the millivolt readings directly input from the thermocouples, using a digital voltmeter which will read the millivolts directly, and then they can be converted to a temperature in the usual manner.

And in the period between 8:00 o'clock and 9:00 o'clock in the morning, there was a core map taken of those thermocouples which showed that the center of the core was very hot. There were half a dozen thermocouples in there

which were over 2,000 degrees F. And the peripheral thermocouples, moving toward the outside of the core, which were progressively cooler, some of the ones on the outside were reading approximately the expected water temperature at that time.

But that measurement in itself indicated there was a region in the center of the core which was not being cooled, in spite of the fact that the water level was well above that presumed location.

Similar readings on the thermocouples were taken every few hours throughout the first day, and hourly or daily at least for the next large number of days in the plant. And it took about three days before all of the thermocouple readings had dropped to the saturation temperature. So it took several days before the hottest portions of the core cooled back down again to saturated temperatures.

DR. JORDAN: And that was because of the severe damage of the core preventing any circulation of water into those regions, or was it that they were just so hot that the water couldn't contact it?

WITNESS JOHNSTON: The answer in a sense is yes to both. That region of the core was evidently hot enough that water was excluded from it. It was above -- you couldn't wet the surfaces; consequently, it didn't penetrate. This

is our interpretation.

And basically, I am still talking about this time period up to about six hours or five hours. Following and during this period, the block valve was open and closed periodically so that some of the hydrogen was removed from the system during that period of depressurization. It would have been removed out the PORV and into the containment. So that was one period when hydrogen was being removed from the primary system into the containment.

There was a particular event that occurred at 3 hours and 45 minutes into the accident. If you refer to that, to the charts, if you look at the blue line, the primary system pressure at about 3 hours and 45 minutes, you will see a very sharp rise in pressure of about 300 pounds. If you look at the red line directly beneath it, which is the source range monitor, you will see a sudden upward jump.

If you look at the next set of curves above it, namely the cold leg temperature plot, you will see a sudden increase in temperature of two of the blue lines.

All these, all this evidence has been -- and also not shown on the chart, the self-powered neutron detectors at the lowest levels, the lowest elevations in the core, the first and second ones, briefly went off scale and returned back to scale.

All of this evidence has been used to deduce the

fact that there was a sudden rearrangement of the core geometry at that time, which resulted in additional damage to the core and additional hydrogen generation. That is the second period of time, a relatively short period of time, in which additional hydrogen was generated, estimated at approximately another 100 pounds of hydrogen was generated in that time period.

BY MR. SHOLLY:

Q Sir, do you mean 100 kilograms

A I said that in pounds.

Q That is pounds?

DR. JORDAN: You mean 50 kilograms?

WITNESS JOHNSTON: 50 kilograms, roughly. Let me correct that. No, it had to be -- it was about 100 kilograms that was produced in that time period.

In our analysis, that was the last time that significant amounts of hydrogen were produced during the accident. There was a time later on where there has been some postulation that possibly a portion of the top of the core was uncovered again, although, as I suggested, that was not our interpretation.

But even if it occurred, the top, the part of the core that would have been exposed, was the part that had already been extensively oxidized. There was very little zircalloy left to react, and therefore our conclusion that

there was no significant amounts of hydrogen produced after roughly 4:00 o'clock -- or four hours into the accident, would still be a consistent estimate.

DR. JORDAN: What time was the containment pressure blip?

WITNESS JOHNSTON: That was about ten hours, ten hours into the accident.

Following that, then, in summary, approximately 450 kilograms of hydrogen were produced. In the next time period, which runs roughly from five hours to about seven and three-quarters hours, was the period that has often been called the feed and bleed period. The intent of the operators at that point, as we interpreted their words, was to raise the pressure in the system to try to collapse the noncondensible steam which they felt they had in the hot legs, which was keeping them from getting water in in the quantities that they could turn the pump on.

The steam was superheated and their intent by raising the pressure was to condense it, and hope that they would thereby reduce its volume and condense it. They were not considering the fact that there was hydrogen in there, which that wouldn't happen with hydrogen.

So they raised the pressure in the system and went into what we call a feed and bleed mode. And you can see the cycling that they went through there. They were putting

water into the system, it was coming in through the makeup pumps. You'll see that both the B and the C pump were on in this time period. The water was apparently entering through the cold legs, passing through the core, out through the hot legs, through the surge line, into the pressurizer, and out the top of the pressurizer, and finally into the drain tank and into containment.

And the cycling mode that they were in, basically, if they closed the valve the pressure would rise and if they opened the valve the pressure would drop. And they were running about a five-minute cycle during that period.

If we estimate by taking the slope of the rate of increase of the pressure, when the PORV was closed, and an estimate at least of the rate of coolant flow that is going in there, we are able to make a calculation of the probable volume of noncondensibles in the system at that time. And that estimate was there were about 2400 cubic feet of noncondensibles in the system at that time.

The volume of noncondensibles -- I mean, the distribution of them -- we cannot be fully positive about. But in general, it would be, as I described before, roughly the region at the top of the vessel, the upper half of the hot legs of both steam generators, about 500 cubic feet in each steam generator and in the cold legs, including the pump volume, so that the pump rotor was not sitting in water

but was with noncondensibles surrounding it.

Incidentally, the curve, the picture is incorrect on our schematic in that it shows the pump as located at the bottom of the steam generator, and you're probably aware that it's really located at a much higher elevation.

CHAIRMAN SMITH: Is the cold leg entry correctly demonstrated into the reactor vessel?

WITNESS JOHNSTON: Basically, but the hot legs and the cold legs are at the same elevation. But for graphical reasons they couldn't show them at the same elevation. But they are a ring of six at the same elevation around the reactor vessel.

During the period of feed and bleed, as I said, they hoped to remove -- they hoped to condense whatever it was that would be condensed in there, hopefully steam. They did this for a long period. Again, they felt they were unsuccessful in achieving their goal, namely getting enough water in that they could start a pump.

So they changed their strategy at this point and decided again to try to depressurize the system and reduce the pressure to a level that, first, the accumulators would come on and flood the core and, secondly, they could hopefully get down to the decay heat removal system and start it up.

Now, the accumulators would come on, I believe, at

about 600 psi, and I think they have to get down in the neighborhood of 400 to get the residual heat removal system operating.

MR. CUTCHIN: For clarity, Mr. Johnston, the term "accumulator," that is identical, is it not, to the term "core flood tanks" as it appears on these charts?

WITNESS JOHNSTON: Yes, it is.

In the mode, then, roughly or depressurization, which, if you refer to the primary system pressure curve that we have been following, that is the period where the pressure drops from 2,000 down to the neighborhood of 500 to 600 psi. This was accomplished by opening the PORV and reducing the flows of the water in the makeup pumps.

During this period, they got a good period of the hydrogen out of the system. They were removing hydrogen during the feed and bleed portion of the operation. But more importantly, when they did the depressurization they apparently got relatively -- they got the largest amount of the hydrogen out of the system.

It went into the containment and, as we mentioned before, at about ten hours into the accident, there was the deflagration or the burn inside of the containment.

BY MR. POLLARD: (Resuming)

Q Could I ask one clarification question, please. You keep referring to the opening or closing of the PORV.

Do you really mean opening or closing of the PORV block valve?

A (WITNESS JOHNSTON) Yes, that is correct. Actually, the operators were uncertain in later testimony as to whether they were able to use the PORV itself later on in the accident. So the record is not clear as to whether they did get back to using the PORV. But generally, I should be referring to the block valve. That is generally the nomenclature we have used.

WITNESS MARTIN: If I may interject one comment supporting what Bill has said, especially during this latter period of time, there is conflicting statements by the operators of either having used the block valve as a controlling device or using the EMOV or the PORV. It appears in the later stages they were able to use the PORV reliably without using the block valve as an exercising device.

They were reluctant to use the block valve excessively because of the fact that it might fail and not be able to be reclosed. So there was always some attempt to use the PORV, and it apparently became successful later on during the course of the incident. So it really is a mixed statement. At times it will be either the PORV or the PORV stuck open and utilizing the block valve.

WITNESS JOHNSTON: Now, I think in this time

period after ten hours and preceding the period at 1400 hours, when the repressurization started and the pump was turned back on again, there were several interesting features of the system which I wanted to draw attention to.

At the time that they were doing the depressurization, their intent was merely to, as I suggested, to get down to a differert cooling mode. But things began to happen in the hot leg temperatures, particularly the A hot leg, which on our chart is the red line, the primary system temperatures.

Just following the burn at 10:00 o'clock, but not related to it, the red l' begins to drop in temperature, which says that the temperature of the hot leg on the A side is now beginning to cool. If you look at the blue line beneath it, you will see that a little after 11, that it begins to rise. And there is a sharp increase just after 11 hours into the accident. And in that time period there is a coincidence nearly between the red and the blue lines.

And if you follow it for the next two hours, you'll see that first there's a deviation and then the two lines come together again, and then there is an additional deviation.

Now, these curves are significant if we want to talk about beginnings of natural circulation in the system prior to the time that the pump was started.

Another point I want to make as part of the interpretation is that in between those hot leg and cold leg lines is a thin black line that is called the temperature of the surge line. And above that is a reddish line which is the saturation temperature corresponding to the total pressure in the system.

During the period where we have data shown, roughly from beginning at seven hours, you'll note that the temperature of the surge line is cooler than the saturated temperature line, but that a little after 10:00 o'clock -- or ten hours, I'm sorry -- the two lines begin to come together.

Now, the temperature of the surge line represents the temperature of the water which would be coming into the system from the makeup pumps, passing through the core, going out the hot leg, into the surge line, and presumably out the pressurizer. So that it reflects in one sense the exit temperature of the water from the core. And it was below saturation temperatures in this time period. However, at about the ten hours it rose to the saturation pressure.

If you refer to the bottom of color plate 3, the three sets of blue bars indicate the methods of heat removal that were being used by the plant during various time periods. In the time period I am talking now, roughly from nine hours on until about 13 hours, there are no blue bars

indicated.

The atmospheric dump valves had been closed. Therefore, the plant was not removing heat by that means. The plant was not steaming to the condenser, either. Therefore, the only way that heat could be removed from the plant at that time would be the amount of water that was being taken out through the letdown line and heat that would be removed by the steam generators themselves simply as an increase in temperature of the water in the secondary side or an increase in pressure.

Now, the curves immediately above the blue lines are the level and the pressurizer -- I'm sorry, they are the level and the pressure of the two steam generators. And if you look closely at the pressure in the two steam generators, particularly the heavier of the two lines, which is the A pressurizer, you will see that in the time period that the hot leg temperature begins to drop and the other events that I was discussing, that there was an increase, a small increase in pressure in the steam generator A.

Also -- I think I'll leave it at that. I will leave it at that. But this was some evidence that there was a heat transfer taking place from the primary system into the secondary system. And I am making the point that there was a coming together of the hot leg and the cold leg temperatures. So it appeared that there was some

circulation taking place and some heat removal during this time period.

DR. JORDAN: The emergency feedwater system was operating at that time?

WITNESS JOHNSTON: Yes, it was. Let me see. Yes. The line above it on the steam generating chart showing the operating range shows the level in the A steam generator and in the B steam generator both. The A was full and the steam generator was about half, running about 50 percent level.

The plant operators felt that they were accomplishing some cooling at this time, according to their statements in the record. However, the management of the plant felt that it was not the best thing to be doing and there were some orders issued, I believe, to repressurize the plant, take it up to high pressures, and then look into the possibilities of starting the pump.

And that repressurization began at about 13-1/2 hours. You can see the repressurization was completed at about 13-1/2 hours, and that at 15-1/2 hours the B pump was momentarily jogged. And if you look at all of the parameter lines at that time, you see that the system pressure dropped very rapidly, that the temperatures in the hot legs and cold legs suddenly changed, as they should have with a little bit of flow going through the core.

So they decided then that it was -- that they could turn the pump on. They did. And you see there, just before 16 hours, that the temperatures in the hot legs and the cold legs began to coincide. The pressure of the system dropped, and they effectively had control of the system again, using one reactor coolant pump to provide the circulation.

I think, Mr. Chairman, that probably is my not too brief description.

MR. CUTCHIN: Mr. Chairman, would you like to have the parties and the Board go into questions now, or would it be better -- would this be an appropriate time to break for lunch, have them think about what was said, and maybe do a better job of preparing questions for afterwards?

CHAIRMAN SMITH: I think this would be a good time to break for lunch. I wonder if we can get by with a somewhat shorter lunch break today.

You're going to object, aren't you?

MS. WEISS: I was going to ask for an extended lunch break so we could get our questions ready.

MR. BAXTER: Mr. Chairman, could I ask how long the other witness' presentation might be? If it's short, it might be more efficient to hear it now and use the lunch to think about both presentations.

MR. CUTCHIN: Mr. Chairman, the other witness has

no prepared presentation. He is here to address questions on details of the scenario that might go somewhat in more depth than perhaps Mr. Johnston could address.

CHAIRMAN SMITH: How much time do you want, Ms. Weiss?

MS. WEISS: Hour and a half.

CHAIRMAN SMITH: All right. 2:00 o'clock.

(Whereupon, at 12:33 p.m., the hearing was recessed, to reconvene at 2:00 p.m. the same day.)

AFTERNOON SESSION

(2:05 p.m.)

CHAIRMAN SMITH: Are we ready, gentlemen?

Before we begin with the cross-examination of the witnesses, perhaps the parties can be helpful as to what the scope of cross-examination should be. It is not a routine situation. The staff, as I understand it, is not relying upon the testimony of Mr. Martin and Mr. Johnston. You rest upon Mr. Jensen's testimony for that issue. You have provided it at the Board's invitation to give us a general background as to the events at Three Mile Island 2 and to be available to ask questions that were put to Mr. Jensen that were outside of the scope of his intended testimony.

Now, the issue -- the problem that we expect to be faced with soon will be, what is the limits to the cross-examination. To keep it strictly within the limits of the direct testimony wouldn't really accomplish what the witnesses were brought here for. Yet to have a totally unbounded cross-examination on anything they might know tends to be chaotic and creates obvious problems.

I guess the Board is going to have to -- unless we get some good advice from the parties, we're going to have to just take it up as it comes and decide what the question is, how far we want to go, and what has to be done to assure an organized presentation and due process.

But before we begin, does anybody want to make comments to the Board as to what the scope of cross-examination should be? Ms. Weiss?

MS. WEISS: As far as we are concerned, we basically intend only to ask questions along the same lines that we asked Mr. Jensen and the gentlemen who were here from the Licensee on UCS Contentions 1 and 2. We don't expect to expand beyond that.

CHAIRMAN SMITH: Core coolability?

MS. WEISS: Core coolability, interpretation of what was happening at various times of the accident.

CHAIRMAN SMITH: Okay. Now, you are not going to be asking, apparently, about modifications of TMI-1 and issues of that nature?

MS. WEISS: No.

MR. CUTCHIN: If they are, these witnesses are not the appropriate ones.

CHAIRMAN SMITH: It seems to me that that would be the case. All right. Well, let's begin.

MR. BAXTER: Mr. Chairman, I just have one preliminary remark I want to make this afternoon if I could here, which is just to record that during this morning's break I filed with the Board the Licensee's cross-examination plans on agenda item number 4.

CHAIRMAN SMITH: Yes, you're correct.

MR. TOURTELLOTTE: Mr. Chairman, one other thing that is not related to this at all. But the Board had previously suggested that the staff try to initiate another hearing with the Intervenors on emergency planning. And tentatively, I have set the 24th as the date, after the close of the hearing or depending on whether the Board could give us 5:00 o'clock or not, perhaps either at 5:00 or 6:00 o'clock, to meet with the Intervenors and the Applicant or Licensee and try and work out some of those problems.

So I wanted the Board to know that we are shooting for that date. And then hopefully some time after that we will advise the Board as to what progress we've made, if any.

CHAIRMAN SMITH: Yes. The Board regards the meeting you're talking about and any other meetings that are necessary to be very, very important, and we will sacrifice hearing time on that day in order to accommodate the parties.

The thing is, I think we should make it clear that participation by Intervenors with emergency planning contentions is necessary, and perhaps an order requiring attendance would be appropriate. But we stressed it again, and I don't know if you had a chance to read our emergency planning order, but we stressed again our strong feelings that an informal preliminary approach to it is very

desirable.

I don't know if it would be particularly appropriate to require Intervenors to work a hard day at the hearing and then begin a long evening of meetings. And I don't know how we can work it out, except to say that we will yield hearing time to negotiating time on this particular issue. I think it is very important.

MR. TOURTELLOTTE: We will try and contact all of the Intervenors and find out what is convenient, and then we will advise the Board as soon as possible.

CHAIRMAN SMITH: Okay.

MS. WEISS: So long as the subject is being brought up about the 24th of November, I have thought of it. As I understand the present schedule, which is to hold hearings Tuesday through Friday of the prior week and then Monday through Wednesday of that week. That gives us -- that would make it, as I see it, physically impossible for us to get cross-examination plans to the Board, if we don't have one day in our office in those seven days. Even if we could write it, we could not get it typed and to the Board.

CHAIRMAN SMITH: Do you think what may be evolving here is that -- perhaps if the 24th were set aside. You don't have emergency planning contentions?

MS. WEISS: I don't. If the 24th were set aside for that, that would accommodate us. We could stay in

Washington that day and get caught up.

MR. BAXTER: My only problem with Ms. Weiss' point is that it is not even clear that she will have a cross-examination plan due that day. It may be that Mr. Pollard is preparing for cross-examination, which ought to occur on the hearing agenda.

MS. WEISS: We have to cross-examine your witnesses on the same issues.

MR. BAXTER: They might have appeared that Friday beforehand. I just think it's not possible to say now that you've got a problem in getting ready over that weekend, when we don't know what's going to occur on the hearing agenda.

MS. WEISS: I think it is possible to say that having seven hearing days in a row gives us a serious problem in staying ahead.

CHAIRMAN SMITH: What is your thought about the possibility that perhaps the 24th could be set aside for this meeting process? What is your feeling about -- are you optimistic that that process will be helpful and be worth sacrificing some hearing time? You're the wrong person.

MR. BAXTER: I'll let my co-counsel speak except for one observation. It doesn't seem to me that we've got much overlap in either counsel or parties between the emergency planning issues, and I think we'll still be in

UCS's area of the design and modification questions by that time.

CHAIRMAN SMITH: Counsel and parties. Yes, that's true, except you have that, I guess.

MR. TROWBRIDGE: Mr. Chairman?

CHAIRMAN SMITH: Yes, sir?

MR. TROWBRIDGE: I would like to make a phone call to Bob Zahler, who is not in the office today. I'm going to have to try to reach him in Philadelphia before commenting on the 24th. But I am concerned about his personal availability on the 24th.

I do share MR. Baxter's observation, however, that we really have no overlay. UCS's contentions do not involve emergency planning. And Mr. Baxter is on this show while we are in another corner where we can cover emergency planning if Mr. Zahler is available. And I will report back to the Board.

CHAIRMAN SMITH: Mr. Sholly?

MR. SHOLLY: The only way there might be some overlap is going to depend on which contention in particular is involved at that time. A few of mine do overlap with UCS'. I don't have any way of knowing where we're going to be at that point.

If I am not involved at that point and the parties can get together, there is a possibility I can provide some

meeting space near the offices where I work, where we can meet and talk about emergency planning. It depends on how much advance time I get on that.

MR. ROBERT ADLER: Mr. Chairman, the Commonwealth will definitely have some problem with that. I also need to contact our planning officials about the 24th.

CHAIRMAN SMITH: Well, let's get our reports back and then address the problem again.

MR. CUTCHIN: Mr. Chairman, while the record is broken here for other matters, this might be a good time to state for the record that during the morning first thing I provided the Board and each of the parties here a copy of the letter we were referring to last week from Chairman Plesset of the ACRS to the Honorable Morris K. Udall on the subject of Licensee event report studies by the ACRS for the purpose of addressing the consistency of actual component failure experience.

And it is three attachments, one of which was the ACRS fellows' report on the analysis of feedwater transient sequences in B&W nuclear steam supply systems. It has two other attachments as well.

CHAIRMAN SMITH: Okay. Anything further? Proceed.

Whereupon,

ROBERT D. MARTIN

WILLIAM V. JOHNSTON

resumed the stand and, having been previously duly sworn, were examined and testified further as follows:

CROSS-EXAMINATION

BY MR. POLLARD:

Q My first several questions, Mr. Johnston, are just for understanding figures you used in your testimony, and then we'll go to more subtantive matters. My first general question is, are there any other figures in the Rogovin Report which I could use to get more detailed information? For example, there are no horizontal lines on color plate 3, so it is very difficult to determine the absolute value of temperature at any particular time. I was just wondering, are there any more detailed figures available

A (WITNESS JOHNSTON) There are places in the report in earlier pages where we have gone through the sequence of events, in which things are culled out. And what we have done on the sequence of events in the early part of the report is to say, at one hour into the accident this is the status of a whole bunch of parameters. We've done the same thing hour by hour.

You will find that in the pages just around the section we have been talking about, beginning principally on page 493 where we have taken up each period. We then, for example, on page 494, we have listed the principal

parameters during that period of time, which will in part perhaps answer the question you've raised.

In the sequences of events that are in like NUREG-0600, we have similar sequences in the appendix at the back, which appendix starts on page 647. That is Appendix II.1, "Introduction of Sequence of Events." And then we have got it second by second for about the first five days in the back end there. So there are some places there.

Does that answer the question?

Q Yes, thank you.

If we can now refer to color plate 3 from the Rogovin Report, the first bars, as I understand your testimony, represent the operation of the makeup pumps. And the information distinguishes between the makeup pumps operating in the makeup mode versus the high pressure injection mode. Is that correct

A (WITNESS JOHNSTON) Yes. You are referring to the blue lines at the top?

Q Yes, the first three bar graphs.

A (WITNESS JOHNSTON) Yes. The little blip at the top are the periods when the high pressure injection pumps were on.

MS. WEISS: Could you speak a little louder?

WITNESS JOHNSTON: The blip at the top are the periods when we believe that the high pressure injection

pumps were on.

BY MR. POLLARD: (Resuming)

Q Was there not a time period early in the accident -- and by that I mean within the first few minutes -- when the high pressure injection system was automatically actuated by low reactor coolant system?

A (WITNESS JOHNSTON) Yes, that is correct, and that is lost right in the zero marker on there. You don't see them on our chart because five minutes of an hour doesn't show up well enough. But they were there, that is correct.

Q They operated in the high pressure injection mode for about five minutes, and then the operator terminated it?

A (WITNESS JOHNSTON) That is correct, at two different times. I can look up the exact information. I think Mr. Martin's probably got it right here. But both pumps came on at the same time, the A and the C, and then they at two separate times were cut back and finally shut off,, taken out of that mode.

MR. SHOLLY: If you look at item 72 in NUREG-0600, I think that is the first instance.

WITNESS JOHNSTON: Two minutes. And I think the second was four minutes and something or other.

MR. SHOLLY: It begins at 3:06.

WITNESS JOHNSTON: Sorry.

BY MR. POLLARD: (Resuming)

Q Can you for me please describe, and perhaps also reference a figure, so that we could follow you, the difference in the flow paths from the makeup pumps when they are operating in the makeup mode versus the high pressure injection mode?

A (WITNESS JOHNSTON) I don't believe there is anything in our report that would show that. I do have copies of the PNID's for the plant, in which I have marked these flow paths. And if they can be introduced as evidence or something or other, I can discuss them. They are right out of the final safety analysis reports.

MS. WEISS: Could you just refer them to us and see if we have them ourselves? Give us the references?

WITNESS JOHNSTON: Yes. This is -- it is Figure 9.3-6, makeup and purification system for Three Mile Island Nuclear Station Unit 2. That is from the FSAR. And then there is a separate one for the emergency core cooling system diagram, which is Figure 6.3-1.

MS. WEISS: That is from the FSAR, from the operating license review of Unit 1?

WITNESS JOHNSTON: Yes.

MR. CUTCHIN: That's for Unit 2, is it not?

WITNESS JOHNSTON: For Unit 2, excuse me.

CHAIRMAN SMITH: Is it reproduceible? How do you have it?

WITNESS JOHNSTON: It is, but the quality isn't awfully good.

MR. ROBERT ADLER: Mr. Chairman, the restart report is in the report, and I believe some of those diagrams in there would do.

CHAIRMAN SMITH: This is Unit 2, however. I don't know what to do.

MR. POLLARD: I think, if I may offer a suggestion, if we could try and reproduce those, in the meantime I could go on with my other questions.

CHAIRMAN SMITH: The trouble is, I doubt if the yellow marking will reproduce. But at least I think on two sheets of paper we can come up with it. All right, let's see what we can do.

BY MR. POLLARD: (Resuming)

Q The next item on color plate 3 is labeled "On-Core Flood Tanks." My question there is, can you describe for me what the blue indicates? That is, is this based upon a comparison of core flood tank pressure with the reactor coolant system pressure? Or is it based upon the position of the core flood tank isolation valves, or both?

A (WITNESS JOHNSTON) I'm going to ask Mr. Martin to help me answer this one. This one was derived from our sequence of events and from testimony of the plant operators. Our intent in drawing the lines where they are,

that is where the testimony -- either when the system pressures indicated that they should have done it or when they stated in their testimony to us that they thought they did it. Often there's a difference in time between when they thought they did something or other and what other aspects of the record would indicate.

But to the best of our ability, those are the periods when the pressure was such, and they had stated that the valves were open, but there should have been the opportunity for the water to flow from the core flood tanks into the core.

The shaded portion there that follows is the questionable region where there is a difference of some of the various statements between what people have said and what other evidence indicated may have been on them still.

Q Did you care to add to that, Mr. Martin?

A (WITNESS MARTIN) I was going to comment that in the NUREG-0600 section, item 463, that is in the sequence of events section. It is difficult to establish precisely when the core flood tanks in essence made hydraulic connection with the reactor coolant system, because of the fact that there was no overt outrush of water from the core flood tanks.

There was some level variations and some level alarms received, indicating some variation in level. But

there was never a major outflow from the core flood tanks at any given time. So it is at best -- we are at best able to determine the period of time when the reactor coolant system pressure was of the value that should indicate, if you will, a connection through the check valve between the core flood tank and the reactor coolant system.

Q Okay. The next bars are labeled "RC Pump." Mr. Johnston, during most of your testimony earlier today, you frequently referred to stopping both pumps or stopping the first pump and stopping the second pump. Maybe I'll just ask you to clarify whether or not you really meant stopping both pumps in one loop and stopping both pumps in the other loop?

A (WITNESS JOHNSTON) All right. In the early part of the accident, if you look at the blue lines out of the left-hand side of the first couple of hours, there are -- our remark is that there are actually four primary coolant pumps, two in the A side and two in the B side. And when they shut the pumps off, they shut off both pumps in the same side. So they cut off both the A pumps -- I'm sorry. They shut off both the B pumps first and then later on they turned off both of the A pumps.

Later on, when they started pumps up, they were starting them individually, and therefore if I say they started an A pump they were starting one pump.

Q Except for times, then, when you referenced a specific pump number, do you recall any time when you might have said "one pump" that you really did not mean two pumps?

A (WITNESS JOHNSTON) I don't recall exactly what I said. But the only time period in the accident when I would have been discussing two pumps and meant two pumps would have been in that period between one and two hours, when they were shutting them off.

Q Thank you.

The next two bar graphs are labeled "Pressurizer Vent Valve Open" and "Pressurizer Spray Valve Open." Did the opening and closing of these valves have any influence on the accident sequence or any significant influence?

A (WITNESS JOHNSTON) That is a difficult question to answer, for the only value of having the pressurizer vent valve open -- and you notice that it was opened first during the depressurization period -- is that it provides an extra exit, hopefully to speed up the depressurization rate. It is an additional valve on the top of the pressurizer which they can open and close at their will, and they did open it in those periods when they were trying to depressurize; or a little bit later on, when they didn't think they were getting as low pressure as they want, they tried it again.

The spray valve acts as a short circuit or it connects to one of the cold legs, and when the reactor coolant pumps are not on, there will be no coolant, there will be no spray in the pressurizer. Normally you open it when the reactor coolant pumps are on to provide spray into the pressurizer for pressure control.

But when the pump is not on, opening or closing that valve does not move any fluid in or out of the pressurizer, but it does provide an alternative path for gas to flow where it communicates in a direct way from the top of the pressurizer to the cold leg, one of the eight cold legs.

So, we postulated at various times, particularly early in the accident where you see the first two marks at three hours and four hours whether it played any particular role, but we were not able to decide that it did play any particular role.

DR. JORDAN: I guess I am not familiar with the pressurizer vent vlve. Is that just another valve like the PORV?

WITNESS JOHNSTON: Yes.

DR. JORDAN: It is, and there are just two of them there?

WITNESS JOHNSTON: Yes. I think that on Page 492, that faces the chart that we have been referring to, there

is a cross-section of the pressurizer, and you will see something that says vent nozzle right in the center at the top. You will see the relief valve nozzle and then the spray line nozzles, and those are the three things that we have been speaking of.

DR. JORDAN: Thank you.

BY MR. POLLARD: (Resuming)

Q When you answered Dr. Jordan's question that that vent valve was like the PORV valve, did you mean it was like it in the sense that it would perform the same function when it was open, but that it is somewhat different in actual physical construction?

A (WITNESS JOHNSTON) That is correct. In fact, I am not familiar with the detals of the physical construction of the vent valve.

Q Now, in the next bar graph is the label Block Valve Open (EMOV). Am I correct that EMOV means the same thing as PORV?

A (WITNESS JOHNSTON) That is correct.

Q I have tried to listen closely to your testimony this morning, and I recall you explaining the purpose of the opening and closing of the block valve and the PORV in the time period approximately six hours to eight hours, and I was wondering if you could explain to me from your investigation the other time periods at which the block

valve was operated beginning first at about three hours and 15 minutes into the accident.

Excuse me. If you have already explained this this morning, and it is in the transcript, you need not repeat it, but I was not sure that you had explained all of those periods.

A (WITNESS JOHNSTON) I may not have explained each particular opening and closing. I would have incorporated it in the sequence they were operating that. They were using the valve in a general way to control -- as part of the means of controlling pressure in the system, and I could go through and attempt at least a detailed explanation of each time they opened it and closed it in terms of system parameters, but if you will accept a general statement, they were nominally using it as a means of controlling pressure.

Q Actually, I would prefer it if you could go through a little more detailed explanation of each time period. Perhaps if you would take the first time period from approximately some time after three hours up to apparently five hours and 15 minutes.

A (WITNESS JOHNSTON) It was opened, I believe, at three hours an 45 minutes. Can I refer to other portions of our work here, because we have taken these things up almost piece by piece, and if I can refer to the written word here, it will save me having to recall it all over again.

MS. WEISS: If you just tell us what you are referring to, that is fine.

WITNESS JOHNSTON: I will do that.

I am reviewing the sections beginning on Page 517, but I am going to want to be on Page 518, the Period Six, from three hours 12 minutes to five hours and 18 minutes.

If you will refer to the primary system pressure plot on the color table, on Color Plate 3, the presure has just hit a peak, and you will see a little spike at the top, and that corresponds almost exactly with the opening of the block valve. What the are trying to do is reduce pressure. They were running up close to over 2250, and they were threatening relief valve opening, and therefore they opened up the block valve to avoid having the relief valve open.

BY MR. POLLARD: (Resuming)

Q You mean threatening safety valve opening?

A (WITNESS JOHNSTON) Safety relief valve, so they open a block valve to release the pressure in the system, and you see there is an immediate drop in the pressure in the system. It hits a little shelf and sits for a few minutes, and then it continues to drop more steeply.

The next period that starts around three hours and 45 minutes and goes to 4:00 -- four hours, I am sorry, after the start of the accident, again, that coincides with the event that I mentioned that started about three hours and 45

minutes when there was some kind of a reshuffle in the core.

They were during this period trying to continue to reduce the pressure in the system so they could move on to the other modes of cooling, and I believe our interpretation again is, they opened the block valve to try to further reduce the pressure in the core. It coincided almost identically, but actually followed by 30 seconds or so that sudden reshuffle that took place in the core, so we felt it was unrelated to it, but it coincides rather closely.

Q The other time period of interest to me -- excuse me. Were you finished with your explanation?

A (WITNESS JOHNSTON) I am sorry. You wanted me to keep on going and I forgot. The period around four and a quarter hours is a short opening again. You will note that they are trying to reduce the pressure in the core again. Finally, the long period that runs from about four and three quarters to five and a quarter, they are simply trying to release the pressure in the system to get down on the alternate cooling modes.

Q The other time period of interest to me begins at approximately 12 and a half hours and runs to somewhat less than 13 and a half hours. And am I correct that it was during this time period when they opened the block valve? This is also the time period when they were trying to repressurize. Is that correct, or did that come later?

A (WITNESS JOHNSTON) No, they closed the block valve at the 13 and a half hour period when they started the repressurization.

Q Can you explain to me why they opened it for those two times?

A (WITNESS JOHNSTON) My understanding is, they were still trying to get the pressure down so they could either get more water in from the core flood tanks or get on the decay heat removal system. Do you have anything on that?

A (WITNESS MARTIN) I was trying to quickly refresh my memory. I do believe that this period -- this was after they had clearly come down low enough in pressure to be able to attempt to get injection from the core flood tanks, and the system pressure would not reduce any further to go on to the decay heat system. They had to get down around 400 pounds, and they could not get the system down below 500, 550 pounds, and so some of that period was attempts to try to get a depressurization of the system down to where they could get the decay heat system aligned.

Q Okay. The next graph is labeled Pressurizer Level. In your investigation of the accident sequence at Unit 2, do you believe that this graph shown here is an accurate indication of what pressurizer level was?

A (WITNESS JOHNSTON) That was -- This line is an accurate indication of what the instrumentation recorded as

being the pressurizer level. I am quibbling on that because I am not willing to say that I know what the actual liquid level was. The method that was used is a delta P measurement. It depends upon the reference leg being filled with water.

We have had some concerns that it was possible that the reference leg may not have been full at all times during the accident. We were not able to check that. We were not able to prove otherwise, in spite of some serious efforts to try to check that out, but the line that is indicated is truly what the reactimeter and the instrumentation at recorded levels said it was, and it fits. It seems to fit all right with the sequence of events in terms of what else is going on.

Q And is it correct that if the reference leg was not completely full, that the indicator level would be higher than the actual level?

A (WITNESS JOHNSTON) That is right.

Q The next series of graphs are labled primary system temperatures. The first question I would like to ask you is, can you describe, please, the physical location, the physical arrangement, and the number of temperature instruments from which you derived the hot leg temperatures and cold leg temperatures?

A (WITNESS JOHNSTON) Yes, I think I can answer that

question most satisfactorily if you turn to Page 490 in the book, Figure -XXIII is an isometric drawing of the primary system, and we have indicated on there where the temperature measuring devices are located.

The RTD and the hot legs are located -- on the righthand one you will see RTD temperature HA, and that is the location of the platinum resistance thermometer, a resistance RTD located near the top of the vertical part just before you get to the elbow that we call the candy cane. It is located in the same place on the B part of the system.

So, there are two temperature indications that we get from the hot legs. One in each. On the cold legs, the temperature is measured just below the inlet to the reactor coolant pump, and you will see that in the lefthand side of the drawing. It is called T sub CB. And that is the temperature location for the -- there are three others located in comparable places.

So, in terms of recorded information, we got the hot leg temperatures from the reactimeter and also from a stretchout recorder which was printing out in the room behind the control room. The cold leg temperatures, there are four of them. Two of them were on the reactimeter. One was on the strip chart and one was not recorded, so that we get only three cold plate temperatures.

MS. WEISS: We are having ahard time hearing you whenever whatever it is that is going on up there goes on. I ask you to please try and speak as loud as you can.

WITNESS JOHNSTON: Okay. I can hear the echo of my voice and probably because of the echo -- Would you like for me to repeat any part of it?

MS. WEISS: No, I think we got it.

BY MR. POLLARD: (Resuming)

Q The only part I did not get is why Color Plate 3 shows only one temperature indication for TCB.

A (WITNESS JOHNSTON) That, as I suggested, we have two thermocouples, TCA. We have TCA 1 and TCA 2, because we had both of those recorded on the reactimeter. In other words, the A leg cold leg thermocouples were recorded on the reactimeter. The B leg thermocouples were not. The data that we have for TCB comes from the strip chart recorder.

Q The next graph is labeled primary system pressures. Is that loop pressure, or is that pressurizer pressure?

A (WITNESS JOHNSTON) I have to think about that one.

I have a table in which I can look this up. My feeling is, it is the pressurizer pressure, but I would rather give you an accurate result if I can.

(Pause.)

A (WITNESS JOHNSTON) We know that reactor coolant

pressure is measured directly on the loop, and it is part of the information that is indicated for the operator in the control room. But what we are not sure about is what the reactimeter derived its pressure measurement from.

Q I will just ask a different question. From your review of the accident sequence, was there ever a substantial difference between the pressure measured in any of the loops versus the pressure measured in the pressurizer, to your knowledge?

A (WITNESS JOHNSTON) Not to my knowledge.

Q Your next bar is labeled Steam Generators, and we have two graphs, one labeled pressure and one labeled operating range. What is this notation BA between those two labels of pressure and operating range?

A (WITNESS JOHNSTON) We have two densities of the line there. One is the heavy black, which is the A, and the lighter gray, if you like, is B. Since we had two steam generators, we are referring to them as Steam Generator A and Steam Generator B, so that for the operating range we have the level for the heavy black line being the A steam generator and the gray one being the B steam generator.

Q The next series of bars are named atmosphere dump on steaming to consdenser and decay heat pump on. These bars where it indicates blue, does this indicate your determination that the core was actually being cooled, or do

those really indicate equipment status?

A (WITNESS JOHNSTON) This is the method of heat removal that was operational in that time period. In other words, they had the capability of removing heat by steaming to the condenser where it is blue line or to the atmospheric dump during the other periods of time.

Q That is what confuses me about the graph then. If you would pay particular attention to the bars for the decay heat pump on, it shows it on at around four and a half hours, at which time reactor pressure was at least 1,000 pounds.

A (WITNESS JOHNSTON) Yes. Now, the decay heat pumps can be on even though they are not in a range at which they can be used. They will come on automatically.

Q That was precisely my question. So that these bars really indicate, at least in the case of the decay heat pumps, equipment status, and they don't really indicate that they were actually removing heat from the core.

A (WITNESS JOHNSTON) That is correct. That is right. It merely indicates a capability -- well, not even -- it is the capability of it, I suppose.

Q I am sorry. I missed a few questions I had back up on the graphs labeled Primary System Temperatures, particularly with respect to the graph labeled T Surge.

Can you indicate where precisely this temperature

measurement is made on the surge line and perhaps also in the earlier figure?

A (WITNESS JOHNSTON) I don't know the answer to that without doing some digging. The surge line, well, it is not perfectly flat, so it is a pertinent question, but I do not know the answer.

Q Do you think it is feasible you might be able to get it during the break, or would that be something you might not have here?

A (WITNESS JOHNSTON) I might not have it here. I might have it here. I have tables of all the instrumentation and where it is located, but it is not always by the inch or that sort of thing. I can look for it.

Q Well, we can have you come back later. Let's go on now.

On the same graph, this T Surge, there are some X's indicated, black X's, and there is a circle with what appears to be a cross in it. Could you please tell me what that designates?

A (WITNESS JOHNSTON) Actually, the crosses are the T Surge measure temperatures and the T pressurizer is the gray line. Again, that is associated with them after seven hours. The black crosses were called out by the operators on the computer. That is why we don't have a continuous record. But if they wanted that information, they could

call it up, and it was on the computer. It was a permanent record. And that is why we only have X's periodically on there.

The pressurizer temperature had capability also as being recorded continuously, but they were not until the eighth hour.

Q Okay. Am I correct, then, that the solid line which approaches TH and TC at around eleven hours is really the temperature of the pressurizer not the temperature of the surge line?

A (WITNESS JOHNSTON) That is right.

Q Finaly, I have just a few questions on the other figure you used, Figure II-30.

A (WITNESS JOHNSTON) II-30?

Q Yes. That was on Page 513.

Are the temperatures indicated on Figure II-30, are those calculated or observed temperatures?

A (WITNESS JOHNSTON) These are calculated temperatures.

Q Can you explain to me what it means, please, a one foot node which is the label at the top of the graph?

A (WITNESS JOHNSTON) Each of those numbers you see on the line, 0, 1, 2, 3, 4, 5, are elevations from, down from the top of the core. So that every foot we were indicating the calculated temperature of the core as a

function of time.

Q Now, these are calculated temperatures where within the core? Radially and axially?

A (WITNESS JOHNSTON) Axially, they are located as indicated. They are one foot down from the top or two feet down or three feet down. Radially, the particular figure that we are looking at is for the portion of the core that has a radial peaking factor of 1.467, which is roughly the center of the core.

Q Can you please tell me what the designation H sub C equals 3 to the right of the graph is?

A (WITNESS JOHNSTON) That is the heat transfer coefficient. Heat transfer coefficient to steam in BTU's. In other words, that is the rate at which the cladding would be exchanging heat. Yes, exchanging heat. Exchanging temperature with the steam that is rising. It is a measure of the efficiency of the heat removal.

Q Does that have some units associated with it?

A (WITNESS JOHNSTON) The rate of the heat transfer coefficient plays a large role in how much, how rapidly you can remove the heat.

Q You misunderstand my question.

DR. JORDAN: I think you said the units was BTU. I presume you mean --

WITNESS JOHNSTON: It is in BTU. It is units per

square hour per --

MR. POLLARD: Thank you.

BY MR. POLLARD: (Resuming)

Q On Figure II-31 is time zero the same time zero there as it is in Figure II-30?

A (WITNESS JOHNSTON) Yes. It is. We simply boiled down at different rate.

Q That was going to be my next question. What does the label 20 minutes to boil down to eight feet and 33 minutes to boil down to eight feet mean?

A (WITNESS JOHNSTON) In the course of our study in trying to estimate the time at which the core began to heat up, and using the temperature curves of color plate 3, you will note that the time that the hot leg and the cold legs begin to diverge cannot be established absolutely because the A-1 goes at a different time from the B-1, so we had two differences of approach as to at what time the heat-up began.

So, we make calculations, both -- we know when the heatup starts, but we weren't sure when it started, so the question was, did it take 33 minutes to cover the boil down unit or did it take 20 minutes? So we made calculations to cover both instances, and what we display here is the differences between the two assumptions.

It does not change the temperatures reached much, but it changes slightly the time.

Q Thank you. What I would like to do now is ask you some questions about your actual testimony, and since I may have made errors making notes, I will sort of paraphrase what you said and see if that is accurate, and then I will ask you the question.

Oh, before we go on, as I understood you earlier when I asked you the question about the difference between the flow paths for the makeup versus the high pressure injection mode of the makeup pumps, you referenced two figures. Now, I have in front of me a copy of Figure 6.3-1, and I can see where you have colored the lines.

Is this an indication of the path for makeup flow or for injection flow?

A (WITNESS JOHNSTON) Well, the answer is both. The reasonfor that is that right in the center of the page are three pumps. They are called NP -- or HP, high pressure pumps. That is the makeup pump 1-A. I am sorry. The makeup pump A, the makeup pump B, and makeup pump C.

The one in the middle, you note that the source of the water, it says from MU tank, and that is the B pump, and that is the one that is normally used for makeup, so that the water enters from the right, from themakeup tank. It goes through the pump, follows that line down the center, and then hits the -- I don't know how to describe this. It hits a T, and then moves into one of the four cold legs, and

that is the normal makeup pump flow.

When you get ECCS injection nominally that B pump in the middle stops and the ones at the top and the bottom, the A and the C, then start, and then there is a valve realignment so that the A pump feeds, and it splits and feeds into two cold legs.

And the pump at the bottom splits and feeds into the other two cold legs. And the source of water is different when you go into the high pressure injection mode.

MS. WEISS: Will it be possible to have this diagram bound into the record, or will its size preclude it?

THE REPORTER: Yes, we can have it bound.

CHAIRMAN SMITH: Is that your desire?

MS. WEISS: Yes, Mr. Chairman.

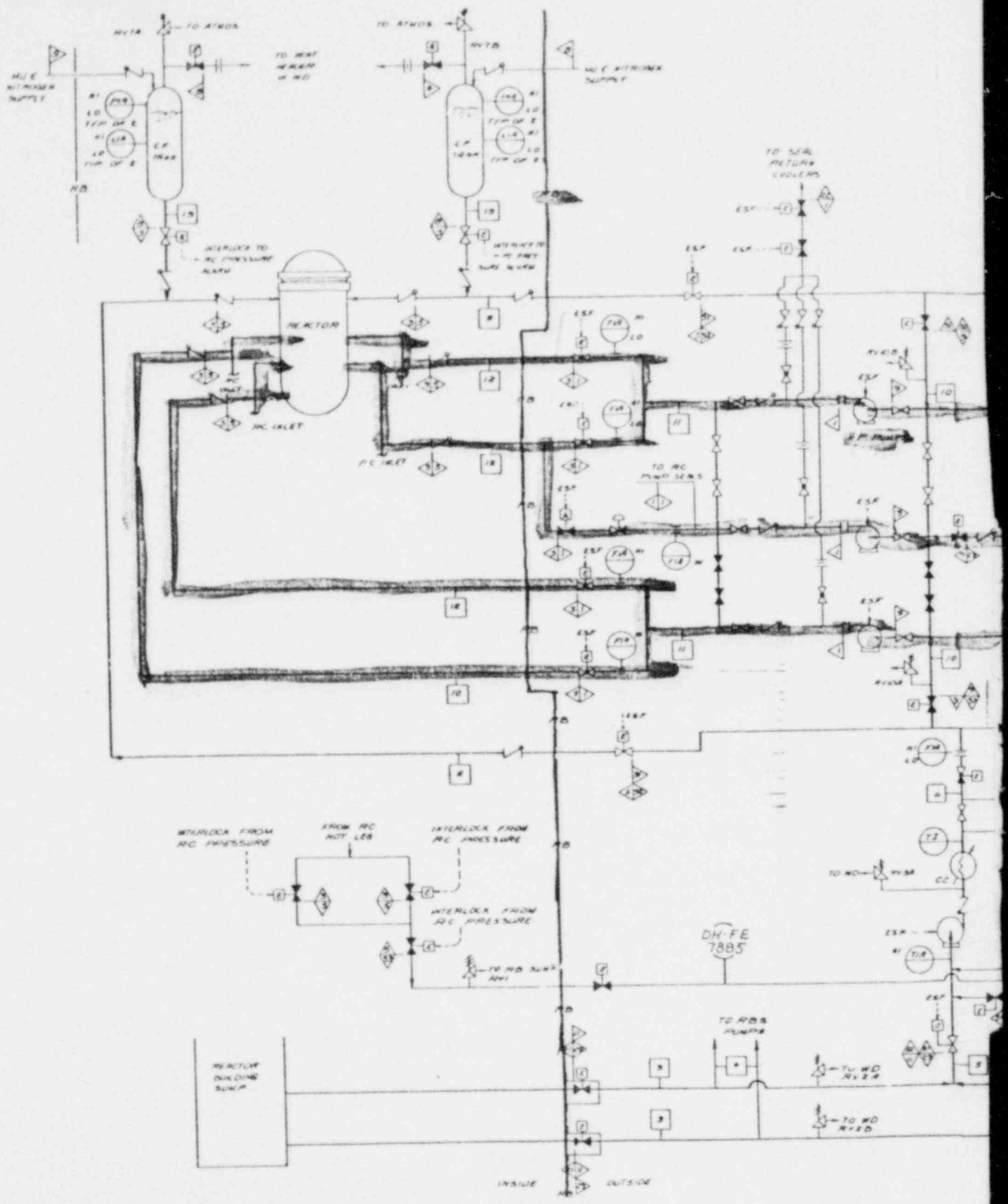
CHAIRMAN SMITH: Is there any objection?

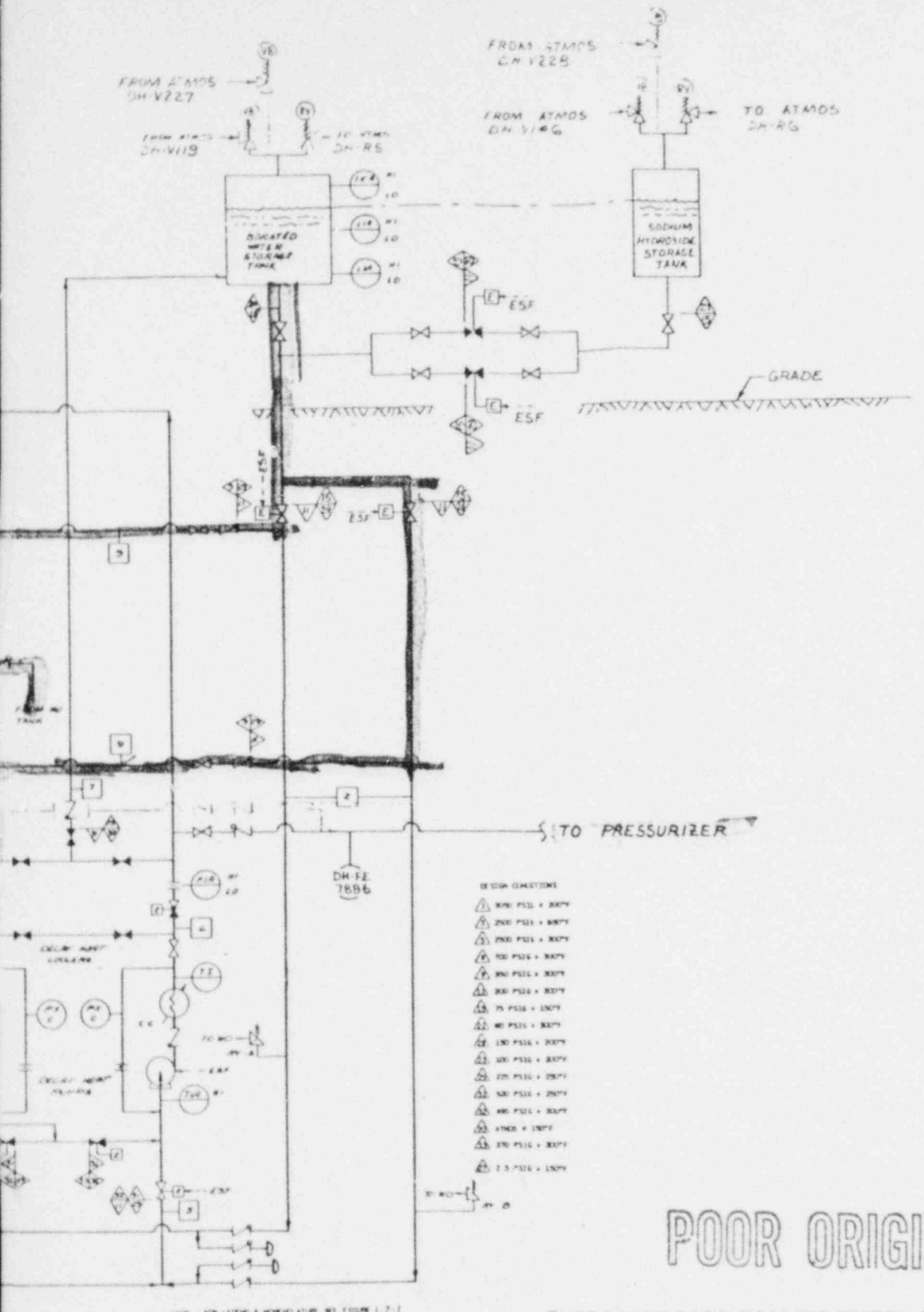
(No response.)

CHAIRMAN SMITH: We will have Figure 6.3-1, emergency core cooling system flow diagram for Unit 2 from the FSAR bound into the transcript at this point.

(The material referred to follows:)

POOR ORIGINAL





POOR ORIGINAL

EMERGENCY CORE COOLING SYSTEM FLOW DIAGRAM

THREE MILE ISLAND NUCLEAR STATION UNIT 2

FIGURE 6.3-1

AM. 59 (10-7-77)

MS. WEISS: Does the reporter need one copy?

THE REPORTER: Yes.

BY MR. POLLARD: (Resuming)

Q As I recall your testimony earlier, you were describing the water levels in various portions of the reactor coolant system after the first set of pumps was shut off and Loop B and then the second set of pumps was shut off in Loop A, and as I understood you, you said that the water level on the primary side of the steam generator A level was not high enough for natural circulation.

Am I correct in that?

A (WITNESS JOHNSTON) Yes. That is correct. That is the side that the pump had been drawing the water from and had been removing it faster than it had been condensing into that steam generator. And besides, the letdown line is also located at the bottom of the steam generator so that there is more reasons to draw water off.

Q At this point in time, was the level on the primary side of Steam Generator B high enough for natural circulation?

A (WITNESS JOHNSTON) Yes, it would have been. It was half full, and the water level inside the steam generator would have been equal to the level of the cold leg entrance into the reactor vessel.

Q During the Three Mile Island Unit 2 accident, was

it Steam Generator B that was isolated because they thought they had a steam --

A (WITNESS JOHNSTON) Yes, B was isolated at various times.

Q Can you explain to me what it means, please, to isolate a steam generator?

A (WITNESS JOHNSTON) Basically, it means that you close the valves that tie the secondary side and to the heat sync so that you don't remove heat from the secondary side, don't remove flow from the secondary side.

Q Do you also close valves that would prevent feedwater flow into the steam generator?

A (WITNESS JOHNSTON) Yes, you do. Yes, you stop feedwater flow at that point.

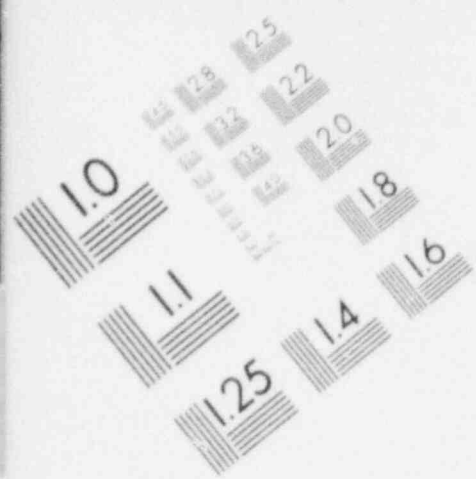
CHAIRMAN SMITH: Mr. Pollard, you have no objections to having the answer supplied in that fashion, do you? I mean, I don't see any problem with his getting the answer from Mr. Martin.

MR. POLLARD: No, I have no objection.

BY MR. POLLARD: (Resuming)

Q Do you know from your analysis of the accident sequence the time periods that steam generator B was isolated and the time periods when it was not isolated?

A (WITNESS JOHNSTON) That is in the sequence of events. Both NUREG-0600 and ours have those periods



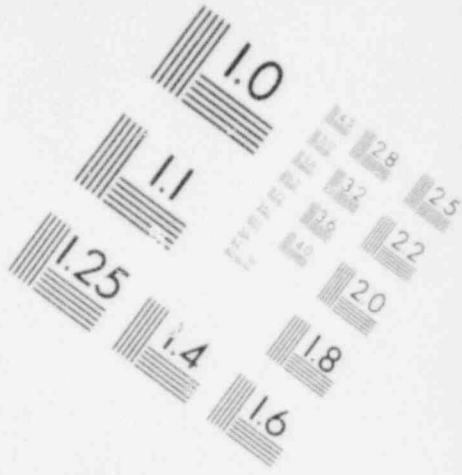
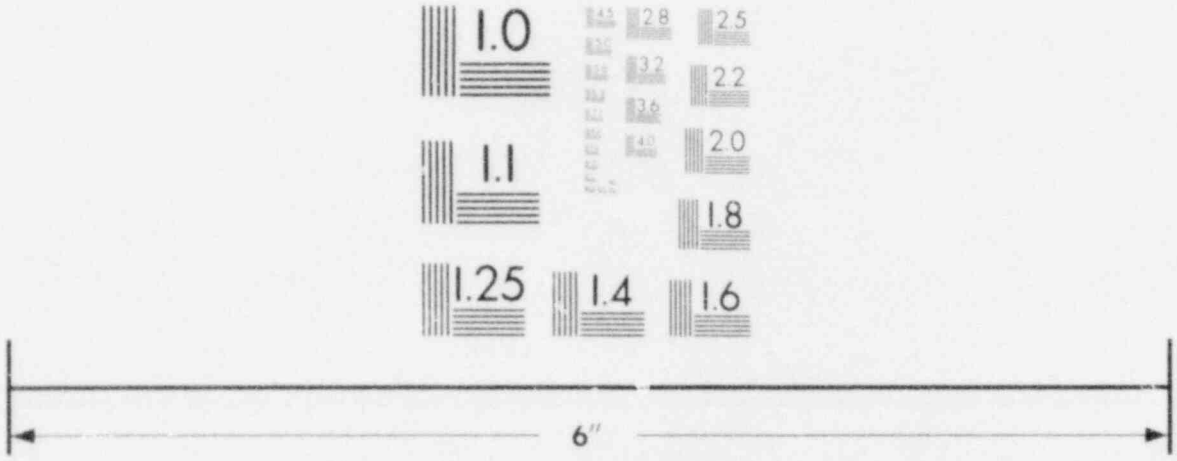
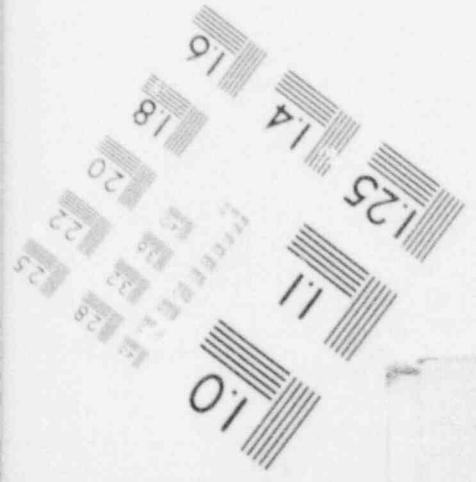
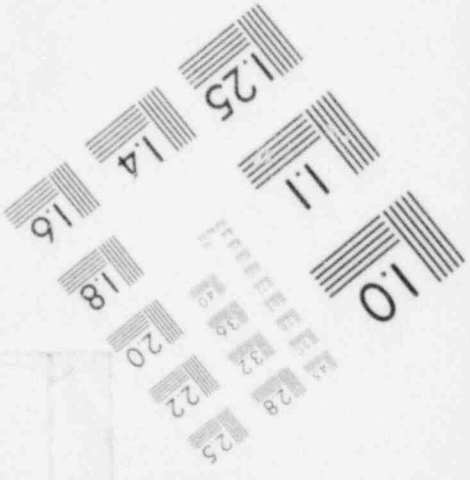


IMAGE EVALUATION
TEST TARGET (MT-3)



MICROCOPY RESOLUTION TEST CHART





indicated in the sequence.

Q If I can move on to my next question, as I recall your testimony, you were talking about a time period close to three hours into the accident -- as I recall, it was two hours and 54 minutes -- when reactor coolant pump 2B was started, and as I recall your testimony, you stated that this action, meaning starting of the reactor coolant pump, terminated the temperature rise and quenched the core, but also contributed to the damage to the core because the cladding had already been brittled, and when it was hit with water, it then was further physically damaged. Is that correct?

A (WITNESS JOHNSTON) Yes.

Q If at that time when the reactor coolant pump was started water from any source was put into the reactor, would not the same damage have resulted?

A (WITNESS JOHNSTON) That is difficult -- Well, you are probably correct. Certainly the rate at which it was put in when the pump turned on put a great big slug of it, so there was also physical momentum if you like on the water coming in.

If it had been put in, say, by turning on a makeup pump and raising the level gently, then I would conclude that there would have been less damage because there could have been a slower cooldown, although under the

circumstances of what had already taken place here, I am not sure there would be a great deal of difference between the two cases.

Q As I recall your testimony of the time period beginning about six hours into the accident, then up to perhaps let's say ten hours, that their first strategy had been to try to pressurize the system, and then they changed strategy and attempted to depressurize the system, and as I recall, you testified that they somehow came to the conclusion that pressurization was unsuccessful. Am I correct?

A (WITNESS JOHNSTON) Yes, we said that.

Q My question is, how did they know that the pressurization was unsuccessful?

A (WITNESS JOHNSTON) They were getting no response from the temperatures of the hot legs for one thing. During that time period, they were monitoring, measuring the temperatures in the hot leg, and hoping to see them begin to fall, and if you will note on the primary system temperature curves that there was no change in either the A or the B leg, hot leg temperatures, so that that was one evidence that they got that they were not making progress in cooling or getting the core in the p e where they could get more adequate cooling in the system.

Q If we can now move to the time period beginning

about eleven hours or perhaps slightly before that, as I recall your testimony, you stated that the indication of the temperature of the pressurizer rising to the saturation temperature and the hot leg temperature of Loop A and the cold leg temperature of Loop A all coming together indicated that the core was being cooled. Is that correct?

A (WITNESS JOHNSTON) It indicated that some circulation was beginning to take place in the primary system, and there was evidence of some heat removal through the steam generators.

Q Which particular indication indicated heat removal through the steam generators?

A (WITNESS JOHNSTON) All right. There are several indications. First, I suppose, it is indirect, but the fact that the hot leg temperatures were dropping for the A hot leg so that you were getting some kind of flow past the resistance thermometer up there at the top of the hot leg because it began to cool, so there must be something moving.

Secondly, if you look at the pressure indication for the steam generator for about the same time, you will notice that it has been running flat, but at about ten hours and a half there were some little rises in the pressure, and that was taken as indication that there was heat being absorbed by the steam generator and resulting in an increase in temperature then in the secondary side.

In the operating range -- well, I think that -- Oh, the second point is that also at the same time, if you look at the level in the operating range for the A steam generator, you notice that at the same time that the pressure goes up, the level has a little drop. It is just a little kink in the curve, and again, that would correspond to evaporating some water because it absorbed some heat from the primary side.

(Pause.)

DR. LITTLE: Dr. Johnston, in the chart that shows the primary system temperatures, what is the maximum range that can be read by the temperature sensing devices there? Are those actual maximum temperatures that were reached in the hot legs? Or is that just as high as the system would record?

WITNESS JOHNSTON: These are the highest temperatures that were read in the hot legs, in this case mostly by the strip chart recorder which had an upper limit of 800 degrees F, and the line stayed on scale, running just slightly under 800 for much of this period of time, but it was clearly on scale, on the strip chart recorder, except for one very short period, the little peak I think that you see there at three hours and a half, where it went a little bit off scale on the strip chart and then came back on scale.

So that the answer is, as far as we know, the

strip chart was on scale and was reading true numbers.

DR. LITTLE: Thank you.

CHAIRMAN SMITH: Go ahead.

BY MR. POLLARD: (Resuming)

Q With respect to the opening and closing of the isolation valves on the core flood tanks, do I understand you correctly that there were sometimes during the accident sequence when the operators opened and closed the flood tank isolation valves?

A (WITNESS JOHNSTON) Yes, it was done both early in the accident and I believe also later on. But I think Mr. Martin has details on that from his scenario.

A (WITNESS MARTIN) I am pretty sure that that is identified. I think we had a specific section where we wrote up the discussion. There is no -- There is no objective evidence of the opening and closing of those core flood tank isolation valves. It does not print on a computer or alarm in any particular fixed recordable fashion. So, some of the time frames -- If I can use the table of contents, I might be able to find it easier.

The section in NUREG-0600 which addresses the core flood tank isolation valve starts on Page I-4-28.

Q Do you know, given the uncertainty involved of whether or not the valves actually were opened and closed, do you know why the operators might have attempted to close

the core flood tank isolation valves?

A (WITNESS MARTIN) In the initial -- from the investigation that was conducted and the interviews that were conducted, we are talking about probably in the first two hours -- I think we estimate somewhere around 0600 was when the valves very probably were closed -- the core flood tank isolation valves, for the first time.

That was during the period where the operators had no discernable evidence to them at that time. They had nothing set in their own minds that they were in an accident. They were at that point trying to recover from an unusual turbine trip. They were at a point in which they were riding with fairly low pressure in the reactor coolant system, and yet they had a solid pressurizer, something which should not have occurred to them.

So, they needed no water inventory. This was all during the same period of time where they had cut back substantially on high pressure injection flow, because again, they needed no water as far as they could perceive from the data that they were looking at and concentrating on.

As a consequence, as best we can determine again from the interviews, the rationale was that at that particular period, they didn't need water, even though they were in the range of 800 or 900 pounds. And they were concerned about suddenly the core flood tanks opening and

getting down on that pressure and coupling those two systems together when they didn't need the water, and it was that sort of rationale that apparently led them to isolate the tanks.

Now, they were unisolated at some later time, and it is not, as I recall, it is not clear -- We never found who finally opened -- reopened the valves, or at least our interviews never pointed out who reopened the valves, but clearly they were reopened at some time later on in the afternoon where they intentially tried to go down to the decay heat removal system.

And at that point, the valves were opened. They did get some connection between the two. But they don't know when that occurred.

Q In the course of investigating the accident at Three Mile Island Unit 2, did you identify any operating procedures or emergency procedures which either directed the operator to isolate the core flood tanks or instructed him not to isolate the core flood tanks?

MR. BAXTER: Mr. Chairman, I hesitate to be disruptive, but given that the scope of the cross examination, I think, ought to be reasonably related to UCS Contentions 1 and 2, I don't see the relevance of the question.

MS. WEISS: I don't see that the licensee has a

right to object to questions of the staff's witnesses.

CHAIRMAN SMITH: Well, at least the procedure referred to should be within the scope or within the context of the accident you are talking about. Certainly that. But with that understanding, he may answer.

MR. STEVENSON: I would hesitate to answer that.

WITNESS MARTIN: I think you were asking, was there any procedure. With my hearing aid, I am not sure that I heard that I am supposed to answer the question as best I remember from Mr. Pollard.

CHAIRMAN SMITH: Yes, you may answer, but the question was quite broad. That is, was there any procedure with respect to isolation valves? And we are interested only in relation to the circumstances prevailing under the accident scenario.

WITNESS MARTIN: During the period of time, in the mode they were in, I would say there were no procedures -- there were no procedures that we found in the normal operating mode procedures or certainly in the emergency procedures which were not in use at that time necessarily, recognizing what was going on at the time, that would direct them to either place the tanks into or out of an operable condition by opening and closing the valves.

The use of the core flood tank isolation valves is usually a function that is wholly limited to the normal

startup and shutdown procedures.

BY MR. POLLARD: (Resuming)

Q In the earlier testimony, Mr. Johnston, we talked about the time period at which the pressure spike occurred in the containment building. In the course of your investigations, either you or Mr. Martin, can you tell me how many indications, whether direct or indirect, were available to the operator by which he could have detected the pressure spike?

A (WITNESS MARTIN) If you speak of indications as a strip chart recorder, there is a strip chart recorder showing reactor building pressure as both a narrow and a wide range indicator in the same strip chart. Additional indications of something having occurred come about from the ESFAS system through the alarm enunciators or the status lights.

That indicates that the convenience break pumps have started, that the four pounder -- I am remembering the trip set points. Approximately the 28-pound set point had been reached, which initiated the containment spray pumps to operate it.

So, in a sense, they are indicating as well that something has occurred to cause that equipment to start, and therefore one would deduce from that that you had a pressure spike in the containment, but those two sets of things would

be the prmiary indicators to the operator that something had occurred in the containment.

Q On the pressure instruments for the reactor coolant system, is it not correct that those instruments, since they measured pounds per square inch gauge, also indicated a negative spike?

A (WITNESS MARTIN) That is correct. On the pressure trace, you can see a downward blip in pressure coincident with the timing of the pressure spike in the containment. This is basically a change if you will in the reference side of the pressure measuring device.

DR. LITTLE: Are those real time indicators? I mean, would they know shortly after the pressure spike had occurred that it had occurred?

WITNESS MARTIN: Both of the devices I was speaking of, one, the reactor coolant system pressure, to see the downward spike there is very subtle. You must look for it, and you will note that it is there. It would not be plainly obvious to the operator in the control room. The reactor building pressure recorder should or would be obvious to the operator in the control room. It is displayed, and it is real time. It is not like a computer where it comes in in late time.

By the same token, the indicators for the status on operating equipment, they actuate as soon as the

equipment starts or the signal is satisfied, and so that becomes a real time indicator.

BY MR. POLLARD: (Resuming)

Q Mr. Martin, you referred several times during your testimony to NUREG-0600. I would like to direct your attention to Pae 8 if I could.

A (WITNESS MARTIN) Page 8?

Q Yes, sir.

There is a section on Page 8 which says, "Among the actions taken that contribute to the accident were," and the fourth item after that says that "failure to establish the conditions for natural circulation when the combined RCS pressure and temperature conditions were outside the procedural requirements."

My question is, does that sentence imply that they have procedures to follow for natural circulation and that although the reactor coolant pressure and temperature were outside the conditions in that procedure, that they nevertheless tried to follow the procedure?

And if that is not what it means, perhaps you could explain that sentence a little bit further.

A (WITNESS MARTIN) If I may, let me refresh my memory by finding it. I believe this is the section of the report where we addressed the attempt to go into natural circulation.

(Pause.)

A (WITNESS MARTIN) The section starting on Page 1-2-32 addresses the -- in the center of the page, we have a section in which we review the operator actions concerning initial natural circulation decay heat removal by the OTSGs. That jargon is one-through steam generator.

At this particular point, there is a procedure. Let me see. I am trying to find the reference while I am speaking. Let me stop a moment.

(Pause.)

A (WITNESS MARTIN) 2102-3.3 was the procedure at that time that described decay heat removal by the OTSG. There are specific limitations, precautions, and various other things contained in that procedure as there are in almost all operating procedures. And also, one of those things contained is that the reactor coolant system temperature, pressure, and cooldown rates had to be maintained within certain bands.

Q I notice on Page I-2-34, in that section labeled Evaluation, there is a sentence which reads, "The failure to establish the plant conditions as required by the operating procedures" -- I will skip the parenthetical phrases -- "is under consideration as a possible item of non-compliance."

That would seem to indicate then they were trying to follow a procedure without establishing the conditions

necessary for that procedure. Is that correct?

A (WITNESS MARTIN) Yes, that was the prospective in which their actions were viewed, and as I recall from our investigation, when they started picking up the vibration alarms and various other indicators upon cavitation on the second set of pumps before they tripped them, they decided at that point they would go on natural circulation and trip the pumps because of the alarms that they were receiving, and it was that conscious decision, and knowing in our view that once having made that decision, it was then encumbent upon them to utilize the procedure to establish the conditions for natural circulation.

They did not do so. They did not take the overt steps that would have been needed to attempt to establish the system conditions that the procedure called for to achieve natural circulation.

CHAIRMAN SMITH: Mr. Pollard, without suggesting how the Board would rule, it was not necessary for us to go far into the scope of this cross examination when you indicated you would be limiting your examination to the coolability of the core. Mr. Baxter objected. We sort of dodged his objection on other grounds. Now I guess we will have to have a discussion of how far you feel that we should be able to go on this examination.

MS. WEISS: Is the Chairman suggesting there is

something that has been asked up to this point which has been beyond the general heading of coolability of the core or accident sequence?

CHAIRMAN SMITH: It seems to me we are about to go into that area.

MS. WEISS: Our intention at this point --

MR. BAXTER: We are at least at this point addressing sections of 0600 which were not referenced or cited by the witnesses in their direct.

MS. WEISS: I am not sure what sections of 0600 were referenced by the witness. Mr. Martin referred at various times to 0600, and I am not sure what portions, but there has been no indication that there is anything unreliable about what we just asked him. So, I don't see that that is a problem. Let me just tell you what our intention is from this point on.

We wanted to ask -- We had asked both Mr. Jensen and Mr. Jones -- well, I guess Mr. Jones was the witness on the stand at the time -- to specify for us when qualified management personnel arrived on the scene with relevance to the question of whether people who were educated and highly trained were involved in making the decisions that were made.

0600 has a radiological sequence of events for the TMI 2 accident which both of the witnesses have specifically referred to. That sequence of events contains entries for

telephone conversations with B&W, with management personnel, with GPU personnel. My intention would be, rather than to go through all of that, simply ask Mr. Martin whether that reflects accurately when those contacts were made and then refer to those. And that would be all.

CHAIRMAN SMITH: Mr. Cutchin?

MR. CUTCHIN: Mr. Chairman, I think that line of questioning here would appear to be objectionable in that it has nothing to do with whether the core was physically coolable. It has to do with what kinds of people and what decisions they made. It does not really reflect whether the core was coolable, but whether it was or wasn't cooled because of some wrong decision.

CHAIRMAN SMITH: This is what --

MS. WEISS: We thought the purpose of this witness was to at least partially provide responses that Mr. Jensen could not provide for the detail of the accident sequence. I think it ill behooves the staff to object to one question about whether the sequence is accurate.

CHAIRMAN SMITH: Well, now, just a minute. Just a minute. It is not a question of that at all. You are going into areas in which the Board itself is interested, and if there is some need to inquire into it, we are going to accommodate you. But again, there has to be some organization to the procedure. We don't just sit around

asking whatever questions pop up, even though they may be relevant to the proceeding.

MS. WEISS: I think we have been as organized as we could expect to be under the circumstances, Mr. Chairman. I don't think we have held anybody up a minute.

CHAIRMAN SMITH: You have missed the point entirely, I believe.

Mr. Baxter?

MR. BAXTER: It is licensee's view that the line of questioning Ms. Weiss just outlined is irrelevant to UCS Contentions 1 and 2, which we still understand on their face to be a challenge to the design capabilities of the Three Mile Island Unit 1 reactor, and not a question as to the mindset or preferences of personnel who might have been involved in the accident at Unit 2.

We are talking about the capabilities of equipment and systems, and therefore, I would object to the line before it is started as irrelevant.

CHAIRMAN SMITH: Okay. I can understand that, but there is another problem that we are going to have, perhaps very soon, and that is, we still have not completed Section 2, particularly the Board's questions about the reliance upon operator's actions and how it relates to the LOCA analysis.

If Mr. Jensen begins to testify, and if we had the

same problem that we had with respect to the first group, we may be right back with these very people.

DR. JORDAN: I suspect that it won't be these very people. There will be questions to Mr. Jensen or to the staff concerning the Board question on UCS 8. And Mr. Jensen did not direct his testimony to that question, but neither do I feel that you are bringing these people here to answer questions on UCS 8. Am I correct about that?

MR. CUTCHIN: That is correct. These people are here to discuss what happened in the Three Mile Island 2 scenario.

CHAIRMAN SMITH: Let's take a break.

MS. WEISS: All I intend to ask the witness, so that the record will be clear, so that the scenario accurately reflects the discussions of B&W personnel, GPU, Met Ed management.

(Whereupon, a brief recess was taken.)

CHAIRMAN SMITH: Ms. Weiss, the Board has determined that the line of questioning you have in mind goes beyond the purposes for which the witnesses were brought here, and certainly goes beyond their direct testimony.

MS. WEISS: My exception is noted.

CHAIRMAN SMITH: Ms. Weiss, I will point you to the rules where that is necessary.

MS. WEISS: We don't have any further questions of these gentlemen at this time. Thank you very much.

CHAIRMAN SMITH: Mr. Sholly?

MR. SHOLLY: If I may, I have a very few questions, and it will have to be a few, because I have to leave shortly. Obviously, I am not as up on procedure as much as Ms. Weiss is, so I will proceed.

CHAIRMAN SMITH: If you have a questionabout procedure, certainly feel free to inquire.

MR. SHOLLY: These questions relate to the emergency core cooling system, and the engineered safeguards system, as far as they interact, and then a very brief question about how the operators were following the sequence of events.

CHAIRMAN SMITH: Okay.

CROSS EXAMINATION

BY MR. SHOLLY:

Q I am not really sure which of you to direct this to, so we will try. In looking through the sequence of events in NUREG-0600, there are a number of instances where the emergency safeguard system and containment isolation are initiated and subsequently bypassed. And if you will refer, first of all, to Item 72, which is on Page 1A14, you will note that two minutes and two seconds into the event, ECCS is initiated, high pressure injection.

Is that correct?

A (WITNESS MARTIN) That is correct.

Q And if you go to Item 76, two minutes and 28 seconds -- I am sorry. Item 78, that is, three minutes and 13 seconds -- the safeguard system is bypassed. Is that correct?

A (WITNESS MARTIN) That is correct.

Q By my addition, that is one minute and eleven seconds from the safety system actuating to the bypass occurring. Is that correct?

A (WITNESS MARTIN) That is correct.

Q Okay, if we refer onward, then, to Item 306, you will note that at three hours and 56 minutes, emergency safeguards and reactor building isolation was initiated. Is that correct?

A (WITNESS MARTIN) That is correct.

Q And that at four hours under Item 308, those two safety features are defeated by the operator. Is that correct?

A (WITNESS MARTIN) That is correct.

Q And that is an elapsed time of four minutes between initiation and bypass. Is that correct?

A (WITNESS MARTIN) That is correct.

Q Move on to Item 327. At four hours and 19 minutes, we have an ESFAS channel actuating and according to

the description, 18 seconds later the operator defeats emergency safeguards and building isolation. Is that correct?

A (WITNESS MARTIN) That is correct.

Q Two other instances. Item Number 363. At five hours and 24 minutes, again, emergency safeguards and reactor building isolation initiated and 13 seconds later both of those are defeated. Is that correct?

A (WITNESS MARTIN) Excuse me. Would you back up?

Q At Item 363, the very first sentence there notes that emergency safeguards and reactor building isolation initiated. If you move down, like eight or nine lines, it says, the operator resets the channel, clearing the emergency safeguards, and the reactor building isolation 13 seconds later.

A (WITNESS MARTIN) Yes.

Q Correct? And Item 496, again, emergency safeguard actuation, and from what I can gather from this description, that is cleared within the same minute that it is actuated, although it doesn't specifically address that. Would you agree that that is the case?

A (WITNESS MARTIN) No, it is not clear. The alarming signal, the 20-pound spike cleared very rapidly. The reset of the equipment in that instance occurred at a later time.

Q In that instance, I was not able to find a specific reference.

A (WITNESS MARTIN) Item 507 was when he shut down the spray pumps.

Q Okay. Fine. That was a difference of about six minutes.

A (WITNESS MARTIN) Yes.

Q So we have five instances, then, when emergency safeguards and containment isolation were initiated. On the first instance, it was bypassed in one minute, eleven seconds. The second instance, four minutes. The third instance, 18 seconds. The fifth instance -- or fourth instance, 13 seconds. And the final one six minutes. Is that correct?

A (WITNESS MARTIN) That is correct. I believe one of the -- either the fourth or fifth, without going back through the data, was an erroneous actuation, and it appeared to be clearly an erroneous single channel actuation. It was true that it did actuate, but I believe you would find in the reading on it that it was clearly an erroneous one. The other four, your comment stands.

Q Okay. The reason I bring this up, it is kind of puzzling to me that throughout the entire accident, where in hindsight one of the biggest problems was obviously that it was not sufficient cooling of the core going on, and here we

have five instances where presumably HPI would have initiated or containment isolation initiated and they were very rapidly bypassed, withiin th scope of your review and NUREG-0600, and within the scope of your exerience, do you find anything unusual about that pattern of events as far as resetting or bypassing safeguard systems?

A (WITNESS MARTIN) I think there are a few clarifying points that perhaps would be useful at this point. I believe that there is a note on the first of those instances that the resetting of that signal does not change any equipment status initially. It merely allows the operator to take control and change equipment status if he has justification for doing so.

So, all that merely does is resets the inputting signal which drives everything to an automatic state. That is, starts pumps, opens valves, things of that sort. It does not by resetting shut down those pumps or close those valves. So, I think it is not unusual for certain transients on plants to actuate either erroneously or in an anticipated fashion certain safeguards, equipment, and for operators to reset those signals.

That does not mean that it should immediately follow that they therefore start changing the status of any of that equipment. That would be conditioned upon what the conditions in the plant were, but it is not totally unusual

to see people reset those signals.

In some plant designs, reset is not possible for fixed period of time. Now, that varies by plant design, so that in some cases there may be a fixed timer in that circuit before the operator can reset, but still, will reset in order to take control of selected pieces of equipment.

I think the issue here is more whether or not once having given themselves the option to take control of equipment, that they take the right control of the right equipment and perform the right act, without repeating everything that is in 0600.

I think 0600 contains a number of instances where we felt and identified where operators in our perspective took actions that were contrary to their own emergency procedures or contrary to prudent actions. That kind of a statement does not necessarily apply to each one of the five instances mentioned.

A (WITNESS JOHNSTON) In looking over the five instances, one point is, every time the system pressure drops below 1600 psi, there would be an automatic initiation, so when they were doing maneuvering of the plant there in the first three instances when the pressure was dropping, A, because they were trying to reduce the pressure, any time they passed 1600 they would get an actuation. Well, they were doing something on purpose to do

that.

Some of the second ones, the earlier ones on containment pressure, that was the four psi one, and if it occurred when they were venting, opening the PORV, they would get an increase in containment pressure because they were dumping a lot of steam in it. So, again, I think they knew why they were getting the actuation, and therefore they reset it right away because it was something they were doing on purpose.

But the one at ten hours, the hydrogen fire was clearly an external cause that they let stay on for a longer period of time because they weren't sure what was going on.

Q Okay. The next thing I would like to ask a question about, and again, I am not sure who to direct this to, but it seemed that the operators a number of times were trying to get information on which to judge where the system was headed at any given time. And one of the things that you notice as you go through the sequence of events in NUREG-0600, and I have been able to identify six instances where this was done, the computer was requested to print out a sequence of events.

I will ask you a hypothetical question about that. Could you foresee any point through the TMI 2 accident sequence where if the computer had not been available to print a sequence of events, that could have

prohibited the operators from taking a particular action or could have somehow misled them as to the action that they should take by not having that sequential listing of what had gone on from Point A to Point B.

MR. BAXTER: Mr. Chairman, I have to object at this point. It seems to me we are going outside the scope of the issues and the testimony for which the witnesses were offered. We do have issues later in the proceeding on the computer, and of course witnesses are coming from both the staff and the licensee to address that subject. I don't see how it links up to the availability of forced or natural circulation or the role of the reactor coolant pumps in keeping the core cooled during the accident.

CHAIRMAN SMITH: Mr. Sholly.

MR. SHOLLY: Again, on the legalities, I am not quite sure how to address them. The reason I am raising this is, it seems to me there are at least dozens of instances throughout the sequence of events where operators requested information directly from the computer for one reason or another, and certainly in some of those instances they were requesting information on in core temperatures and the status of pumps on any number of things.

CHAIRMAN SMITH: The difficulty we are having here is that the Board in inviting these witnesses to appear did not really give enough thought as to why they were here and

the limits on their appearance. As a result, we have had to use a considerable amount of judgment as to what the bounds on cross examination are to be. We have gone beyond the limits somewhat of UCS Contentions 1 and 2, although that may be why Mr. Cutchin permitted us to invite them. We are the inviters, and we can do whatever we wish.

We are going to apply similar judgment again this time, and permit your question to be answered with respect to the core cooling aspects that you mentioned.

CHAIRMAN SMITH: That is exactly why I was asking the question. It was related to core cooling.

MS. WEISS: Mr. Chairman, before we go too much further, it is my understanding that licensee is not permitted to object to questions of staff witnesses.

CHAIRMAN SMITH: Ms. Weiss --

MR. BAXTER: Mr. Chairman, may I address that, Mr. Chairman?

CHAIRMAN SMITH: The findings are going to be applied against or for the licensee as well as anyone. And I don't agree with you.

MR. BAXTER: I would not think that I would have to establish my client's interest in this proceeding or any of the testimony.

MS. WEISS: Your client's interest in this proceeding is not the issue.

CHAIRMAN SMITH: Ms. Weiss, in the first place, what are you making, a request for a ruling? I said I don't agree with you.

Do you understand the question now as it has been limited by our ruling?

WITNESS MARTIN: If I understand the question, it is, would the unavailability of the plant computer during the TMI 2 sequence and the ability of the operators to interrogate that computer for information regarding pump status or other critical components have impeded their ability to deal with the accident? Is that a reasonable paraphrasing of the question?

MR. SHOLLY: I think that is a fair representation, yes.

WITNESS MARTIN: I think the answer would have to be yes, it would have impeded them. It would not have precluded them from coping with the accident. It certainly is an instance where all the information you can get is valuable, and that is the most -- one of the more readily accessible sources. It is not the only source of information of that type.

So, I think it would have impeded them. I do not think it would have necessarily caused a change in the course of the accident.

BY MR. SHOLLY: (Resuming)

Q One further question, and this relates again to core cooling, but somewhat indirectly, and I will be combining, I think, features from NUREG-0600 and from the Rogovin report, Item 148 in the sequence of events relates to the diesel generators being tripped locally.

Please correct my impression if I am wrong, but it seems to me that that rendered the diesels incapable of being started on either an auto or manual signal from the control room until some later time which I have identified as Item 364 at five and a half hours.

Is that correct?

A (WITNESS MARTIN) Yes, that is correct.

Q What impact would there have been on the availability of high pressure injection had it been called for during that period from Item 148 to Item 364, had there been a loss of power, a loss of off-site power?

A (WITNESS MARTIN) Had there been a loss of off-site power during that period, the high injection pumps would not have started? They would have no power source because the diesels would not have started until someone was dispatched after the diesels and started them locally there.

Q If you refer to Page 328 of the Rogovin report --

CHAIRMAN SMITH: Part 2 of Volume 2?

MR. SHOLLY: Volume 2, Part 2, Page 328.

BY MR. SHOLLY: (Resuming)

Q The lefthand column, the last full paragraph, beginning with the phrase, "The diesel engines that operate the emergency generators." The very last sentence there indicates that someone would have had to pass through a high radiation area in order to reset the diesel generators to permit them to be used in the event of a loss of off-site power. Is that correct?

A (WITNESS MARTIN) Everything I think you said is correct except I think you said through a high radiation area, and I am trying to find where it makes that statement.

Q That is the very last line on the lefthand column.

A (WITNESS MARTIN) I didn't spot it. Yes, that is a correct statement.

Q Do you have any idea what the radiation dose is or what the radiation dose rates would have been through that area they had to walk through?

A (WITNESS MARTIN) No, I do not.

Q You do not.

A (WITNESS JOHNSTON) Could I comment on that? This was part of the writing that I was responsible for. I think the intention and the way this was written, as I read it now several months later, I think it sounds a little different than what I think we were intending to say when we wrote it.

Our concern when we wrote it was, if the situation had degraded further, there was the possibility that

somebody might have had to go through a high radiation area to get back to the diesels, to reset them. I don't think we wished to suggest that at that time there was a high radiation area that they had to get to. But we were concerned that the fact that they had taken this kind of action made them in jeopardy to the possibility of that kind of thing happening if something had gotten worse and we were not happy with that situation.

But I think it would be wrong for us to have been intimating at that point that there was in fact a high radiation area that the person had to walk through to get to the diesels, because I don't think that was the case at the time. But it was potential, and we were concerned about that.

Q One further question related to this issue. In Volume 2, Part 2, at Page 466 of the Rogovin report, it addresses to some extent the potential consequences of diesel generator unavailability at various points throughout the accident sequence. And the second column under recommendations states that analysis should be performed to determine the consequences of inadvertent interruption of engineered safety features from loss of power at any time during the transient or accident mitigation sequence.

Are you aware of any work that has been done, either started or finished, in this regard?

A (WITNESS JOHNSTON) Yes, I think I can give you some information on that, although this becomes outside of my area of responsibility now. We made these recommendations. The Commission looked into each of these, and has made a response to us. There are two that I can think of. One is called the IREP study, which is being done within NRR. I am sorry, the IREP is being done within the probabilistic analysis staff. And there is another study that is being done by NRR looking at actual plants, and I have forgotten the name of that study.

As a part of the Zion and Indian Point studies, the same kinds of effects are being studied. In other words, what happens if you lose off-site power such that you lose some of these engineered safety features? What are the consequences?

I think those are two I can think of offhand, anyway, where the issue is being pursued. There is a piece of paper in which there is a direct reference to the staff's response to these recommendations, and I did not bring that with me, but I know we could get you probably a more factual answer than I just gave if you would give us another day.

Q That will be fine.

That is all I have.

CHAIRMAN SMITH: Mr. Adler?

MR. ROBERT ADLER: Thank you. Mr. Dornsife has a

few questions on this.

BY MR DORNSIFE:

Q Mr. Johnston, I believe you will be able to answer these questions related to the Rogovin report, and I would like to refer you to the pictorial figure on Color Plate 3, the time sequence of events. On the primary system pressure trace, right before three hours, the elapsed time after the initiation of the transient, after the block valve is closed, there appears to be a fairly constant increase in reactor coolant pressure, and suddenly, right before three hours, there appears to be a quantum jump in pressure.

Can you explain, is that just a -- does that have any significance?

A (WITNESS JOHNSTON) Yes, that is of significance. That is the time that they turned on the reactor coolant pump 2 and put a slug of water into the hot core, and that in our determination was essentially the generation of a lot of steam when the water hit the hot fuel, so it was an expansion of water to steam, and gave a very sudden rise in pressure.

Q Once the pressure was increased to around 2,000 pounds and the core was covered, is there any way of telling either from --

A (WITNESS JOHNSTON) The core was not covered at that time. That was only about 1,000 cubic feet of water

that was sloshed into the core, but that was not enough to cover the fuel at that time. That was not done until later.

Q What time would the core have been covered in this sequence?

A (WITNESS JOHNSTON) It was recovered at those two blue periods, about three hours and a half and four hours, when we show the HPI's were turned on.

Q Once the core was covered, is there any way of telling from the instruments that were available or from any analysis that was done since the accident how much heat was being removed by two phased natural circulation?

A (WITNESS JOHNSTON) I think our testimony said during most of this time period there was virtually no heat being removed by two phased natural circulation because the hot legs were blocked by the hydrogen, and it was at the period of the neighborhood of ten hours and following where I showed that the hot leg temperatures begin to drop, and that changes took place in the operating range of the steam generators, and in the pressure of the steam generators.

So, those are experimental pieces of information that you can use to deduce that there was some heat being removed.

Now, I am trying to recall if we -- we tried to make some analyses of how many calories or how many BTU's were removed. I don't remember that we were able to come up

with a number that we chose to publish. Part of the problem is that some of the changes on the operating range in the pressure, I think, were small. The amount of decay heat that was being produced at that time was small, so there was not a big effect to see. So, I am not sure that we came up with a numerical answer. But the data indicate these events were taking place.

Also, the cold leg rising in temperature as it does, again, shows that you are establishing the proper kind of a delta T that you would get if you were removing heat by that mode.

Q So you are not even sure later on in the sequence after ten hours when there is a convergence at the hot and cold legs whether there was sufficient either single phase or two phase natural circulation to remove the total heat from the core?

A (WITNESS JOHNSTON) Our suggestion was that it was beginning to remove heat from the core.

Q Was it sufficient to remove all of the decay heat that was being produced? Is there any indication of that?

A (WITNESS JOHNSTON: Well, the answer to that would probably be yes, because the system temperature was not rising. Consequently, it must have been in some kind of a ablance. Therefcre, one can conclude that kind of a --

Q So basically you've got enough out of the

non-condensibles ou. of the system at some time to start two-phased natural circulation. Is that what probably happened?

A (WITNESS JOHNSTON) That would be correct. In our estimation, the time they got it out was during the depressurization that started at seven and a half hours. The other indication, as I mentioned, is the fact that those temperatures in the pressurizer rose up to saturation. There was a larger delta T established b tween the steam generator temperature and the primary syste temerature so that you had the strongest driving force for the beginning of circulation that we had had in the system for some hours.

So, conditions were right. You got the hydrogen out. You had the delta T to do it. And we seemed to have som experimental evidence that it happened.

Q So from a core cooling standpoint, probably about that time the system was in a somewhat stable cooling mode.

A (WITNESS JOHNSTON) It was beginning to stabilize. I don't believe we would say it was stabilized. It was beginning to show indications that it could be controlled by that mode, but it was not established.

Q Okay. One additional question. Early on in the sequence when the reactor coolant system pressure initially dropped below 1600 pounds, if either by an automatic trip or by operator action the reactor coolant pumps would have been

tripped at that point, in your opinion, would maybe there have been less ambiguous indication to the operator or the operator would have been better able to diagnose a LOCA and thus take the necessary action?

A (WITNESS JOHNSTON) I am not sure now, the way you have asked the question, what it is that you are searching for. If the pumps are tripped at the same time the system hits 1600, the system would have gone into natural circulation naturally, at least as it has done on other operating plants, though perhaps not a part of our testimony today, but we did take data that other plants around the country have had similar events, and they have gone into natural circulation.

But then the second part of your question seemed to veer from what you are asking me.

Q The question was, the pressurizer level seemed to be the biggest uncertainty in the operator's mind as far as whether he had a LOCA or not, the variability and level, the apparent increase in level in the pressurizer versus the decreasing reactor coolant system pressure. Would that have been significantly different had he tripped the reactor coolant pumps early on in the scenario, and thus he would have been better able to determine if he had a LOCA.

A (WITNESS JOHNSTON) I believe, even if the pumps had been tripped, that the level in the pressurizer would

have continued to rise, so that I am not sure he would have got an unambiguous answer. I believe that would be what had happened.

MR. DORNSIFE: That is all the questions I have. Thank you.

CHAIRMAN SMITH: Mr Baxter?

BY MR. BAXTER:

Q Dr. Johnston, in response to Mr. Pollard's questions, I understood your testimony as to why natural circulation was not achieved in the A loop after the reactor coolant pumps were tripped. With respect to the B loop, I understood you to testify that there was adequate inventory on the primary side, but were there conditions on the secondary side of the B loop that were preventing natural circulation from occurring? And if so, what were they?

A (WITNESS JOHNSTON) The B loop had been isolated at that time. The water, the level was zero in the operating range, and the pressure was dropping during that time period back toward zero. In other words, it was isolated, so it wasn't set up so it could remove much heat.

MR. BAXTER: That is all I have.

CHAIRMAN SMITH: Anything further?

(No response.)

CHAIRMAN SMITH: All right, gentlemen. You are excused. Thank you very much for appearing.

(Witnesses excused.)

CHAIRMAN SMITH: Ms. Weiss, now that we have concluded with this panel, the Board wishes to again bring to your attention your opportunity to demonstrate how your position in this proceeding has been prejudiced by, Number One, their appearance, Two, their appearance under the circumstances that you objected to, and that is, without written testimony in advance, and Three, by our rulings on your cross examination. You may seek appropriate relief.

Okay, shall we go with Mr. Jensen?

MR. CUTCHIN: I guess, Mr. Chairman, I would need a couple of minutes to go pick up some papers, and before I leave, I would like to pass out revised copies of the table that we made available at the end of the day yesterday. It has been retyped in normal bond paper rather than legal, and there have been a few changes as well.

I would also like to pass out the statement of professional qualifications of Mr. Robert. A. Capra, the gentleman who will be walking you through this table, to address the Board's concerns about staff position vis-a-vis licensee position on NUREG-0565 and 0623 recommendations.

May I have about three minutes to run and pick up my papers after I pass these out?

CHAIRMAN SMITH: Sure.

MS. WEISS: I am going to object to this new

witness who I never heard about until just this minute. I want to put the Board on notice that I am going to object to that if it makes any difference before Mr. Cutchin runs to get --

CHAIRMAN SMITH: Ms. Weiss, let's discuss your remark about if it makes any difference.

MS. WEISS: If it makes any difference before Mr. Cutchin goes.

CHAIRMAN SMITH: Okay. Do you want to make an objection now?

MS. WEISS: I was simply going to tell you that I am going to make an objection now. If you want to argue that now or you want to wait until he takes a break --

CHAIRMAN SMITH: All right. Let's take the break first.

MR. JOHNSTON: I was wondering if my other original on the ECCS system is available. Or would that be needed by the hearing board?

(Whereupon, a brief recess was taken.)

CHAIRMAN SMITH: All right. Mr. Cutchin?

MR. CUTCHIN: Mr. Chairman, it is my intent to call to the stand now two witnesses, one, Mr. Jensen, who will support the testimony that he prefiled in response to UCS Contention 8, and ECNP Contention 1E. He will also support, to the extent that he can, the testimony that he

filed relative to Board questions regarding UCS 8.

Now, since the Board had indicated in the last couple of days that it was not satisfied with the staff's addressing of Board Question 8, the staff has brought up another individual who is much more intimately involved, and much more knowledgeable of how the various documents, 0565, 0623, 0660, fit together, and we believe that he could give the Board a better and more sufficient response to the Board's concerns.

I understand Ms. Weiss to say that she has a problem with putting this witness on. It is up to the Board. Mr. Jensen will not be able to go much deeper into the responses to the Board questions than he has indicated in his written response.

The extent of the response of Mr. Capra will be to walk the Board through the chart which we handed out and substance last night, and which we have replaced with a copy that was put into the hands of the Board and the parties during the break. I would suggest that the copy that was handed out last night be destroyed. It was on legal sized paper. This is on eight and a half by eleven paper.

CHAIRMAN SMITH: Ms. Weiss?

MS. WEISS: Mr. Chairman, I object to testimony at this time of a new witness whose name we have heard for the first time in the past five minutes to present a new piece

of evidence which we have not had a reasonable notice and opportunity to review. I believe it is our right under the Commission's regulations and under due process to reasonable notice.

It is not our obligation to show how its lack will prejudice us. It is the burden of the party who wishes to curtail that notice to show some compelling reason why that should be permitted, and I suggest to the Board it doesn't matter whether the evidence is on a Board question or on a UCS contention or on a Board question related to a UCS contention.

I would direct the Commission -- the Board's attention to the Hartsfield case, ALAB 367, appearing at 5 NRC 92, 1977, where the proferring party gave an exhibit to the other parties the night before the hearing and then altered it over objection at the hearing the following day. It was error to meet such evidence, since the objecting parties had no reasonable opportunity to examine it, and I think that applies clearly to this document and even more clearly to the testimony we have yet to hear from the witness.

If staff is saying they didn't take the UCS contention seriously until they saw the Board had questions on it, it is not our burden of proof. It is theirs. And our rights should not be trampled because they were not

prepared.

CHAIRMAN SMITH: Mr. Adler?

MR. ROBERT ADLER: I just wanted to comment that to be quite frank we did have some problems with the arrangement this morning. Mr. Dornsife had a meeting elsewhere. Had he had either written testimony or some advance notice, we would have been much better able to respond to the witnesses. He either would have been able to have briefed me better or to have been here himself to have read the direct testimony.

CHAIRMAN SMITH: Mr. Baxter?

MR. BAXTER: We have had Mr. Jensen's direct written testimony in response to the earlier UCS Contention 8, and now the Board question. It seems to me long enough for the parties to have prepared cross examination. If we hear from Mr. Capra this evening on what I understood to be the response to the Board's inquiry on our answers to NUREG-0565 and 0623 recommendations, it seems to me we might be in a better position then to understand whether there really is any prejudice to proceeding with cross examination in the morning on Mr. Capra's direct from this afternoon and the direct testimony from Mr. Jensen that we have had available for some time.

We have no objection to proceeding.

CHAIRMAN SMITH: Well, the Commonwealth has

correctly observed that there is a value to pre-filed written testimony. However, the Commission's regulation on the pre-filed written testimony is not a substantive right. It is a procedural requirement which, of course, relates very much and affects substantive rights that cannot be denied.

The basic requirement that the law imposes is that there be a full right of cross examination and confrontation. And there are many methods by which that can be accomplished. Boards are given wide latitude on how they go about it, only one of which is the prefiled testimony. And, of course, as we have observed, as we stated, with respect to this most recent panel, UCS and any other intervenor will be given a full opportunity to come back in any manner without prejudice.

However, there are two other problems. One is, as this hearing proceeds, there is going to be many times, I am sure, in which the Board is going to want to have additional information as it occurs to us.

Ms. Weiss, is it true of you that we cannot do that unless we go back to first base or go back to Go and start the whole procedure over again? Is there nothing the Board can do to gather information quickly without going through this procedure? You think we are constrained to follow it no matter what the circumstances are?

MS. WEISS: I said this morning that there are occasions in this case where we have not received prefiled testimony within the 15-day limits. One of the witnesses who is going to get on, Jensen, we received that sitting here last Thursday. I have not objected to that, where I thought we had adequate time to get ready.

Considering the restraints upon us, sitting here is one lawyer, five or six on that side, five or six on that side. Now, I simply think that this is an unreasonable burden. It is presumptively prejudicial. And it -- we have not had a chance to look at it.

CHAIRMAN SMITH: I don't understand. I thought the argument you were making citing Hartsville were that these were absolute rights that cannot be departed from.

MS. WEISS: No, I have not taken the position that every piece of testimony has to be in here 15 days ahead of time. But I just think we have crossed the line. I think we crossed it this mornig, and I think we are leaping over it this afternoon.

CHAIRMAN SMITH: Now, this morning, we discussed that very, very thoroughly, and perhaps it doesn't need any more, but the Board was not happy with the way that came out either. We just did not consider it well enough. The temptation was to litigate the whole proceeding through these witnesses who happen to know a lot about the accident.

So, we did not give enough guidance to the staff what to expect. We didn't give enough guidance to the parties as to what could be expected on cross examination.

The Board felt at the beginning with Mr. Jensen's testimony it needed more background as to the context in which we were going to see these things, these facts develop, and I think that is all right, and I think that we can adjust for any problems it has caused, and we will now.

Now, as far as this witness is concerned, this is a surprise to the Board. I don't see any reason why this man -- I mean, what he is going to do, why he should be here now, why he cannot come back in due course on the particulars, as you stated. He is going to go into specifics of the contention that --

MR. CUTCHIN: This witness is not intending to go into the specifics of the contention. This witness was here to address that portion of the Board's question on UCS 8 which says the recommendations of NUREG-0565 and 0623 should be addressed. I had understood particularly Dr. Jordan to indicate while we were in discussions on UCS 1 and 2 that he was giving the staff some advance notice that he was not satisfied with the prefiled written testimony on the response to Board Question regarding UCS 8 and that he particularly wanted to hear the staff's position vis-a-vis licensee's responses to each one of those recommendations.

And we had Mr. Capra spend the last two days and much of the last two nights putting together a document which would guide the Board and the parties through those various recommendations, show how they relate to other documents that are generated by the Commission. I think there is much confusion about NUREG-0694, NUREG-0660, and a number of other documents, and how these various requirements and recommendations that keep coming at us from all directions interrelate.

It was our intention to have this document, try to pull some of that together to help the Board's understanding. If the Board prefers to have this later, we will accommodate, of course, whatever the Board wishes, but that was the reason we pulled this together quickly, so that we could respond to what we viewed to be Dr. Jordan's desire to have staff's responses to applicant's -- I mean, to licensee's responses to recommendations.

CHAIRMAN SMITH: I think that the subject matter covered here again would be valuable to the Board, but the Commonwealth of Pennsylvania has objected, and so has the intervenor, and I do think that there is at least a presumptive right, as Ms. Weiss says, to have these things in advance.

Now, I think that I would not tell either of the parties, experienced parties, how to try a lawsuit, but I

think that you are throwing obstacles, Mr. Dornsife and Mr. Adler, into a full record by taking the position you are, and you, too, Ms. Weiss.

It seems to be somewhat of an unyielding attitude. However, your point is correct. You do have to have notice. This testimony, I am sure, will go beyond just the interrelation of documents, and will touch rather strongly on substantive matters which can affect your contention.

So, I think that you are entitled to your relief.

MR. BAXTER: Mr. Chairman, just one observation. It seems to me, and I don't have law at my fingertips to cite in support of this proposition, but it seems to me it should make a difference in this case as opposed to what we dealt with on UCS Contentions 1 and 2.

What we are litigating here is a contention that UCS withdrew. It is being heard only because the Board expressed an interest and chose to pursue it.

CHAIRMAN SMITH: But the law of the Commission is clear that intervenors have a right to address Board questions as well as their own contentions, and if the Board question satisfies some of the Board's concerns as to the issues, the intervenors are prejudiced by that, and so they have a right, I believe, to -- I wouldn't want to measure precisely how much confrontation right they have, but they

have a right to a fair confrontation of the evidence presented in response to the Board's questions.

Now, I want to go to Mr. Dornsife's convenience or inconvenience. This is going to be one of the problems that is going to prevail throughout the proceeding. There may be many times when evidence will come up that you could not plan for, Mr. Dornsife, so we will not be able to provide relief to you of that nature.

MR. ROBERT ADLER: I just want to note for the record that we did not object to the new witness. I was merely noting that my observations that we did have some difficulties.

CHAIRMAN SMITH: That you would prefer to have the written testimony?

MR. ROBERT ADLER: That we would have preferred it. The Commonwealth has one nuclear engineer who is responsible for every plant in operation and under construction in the Commonwealth, and that is just a burden on our resources. We are trying to do the best we can.

CHAIRMAN SMITH: Okay.

MS. WEISS: Mr. Chairman, may I note that the document references NUREG-0737, and we have not been served a copy, nor have we seen one of those. And to anticipate future problems, we would ask the staff to produce a copy of that for us, please.

MR. CUTCHIN: As we have indicated, Mr. Chairman, that document would be served on the Board and the parties at the time we received back the copies from the printers. There is available a stapled together form of the document as it went to printers before final typographical corrections and so forth. Substantively, that document should not change. I have enough copies available here that I could pass that out if it becomes important.

Mostly, it will deal with implementation dates. A lot of the substance of what is in 0737 is the document which certain intervenors were disturbed about being produced back on September 5th. That is the Eisenhut letter of September 5th. That makes up the substance, as I understand it, of 0737.

MS. WEISS: Well, if you will stipulate that there are not any substantive changes there, it won't serve any purpose.

CHAIRMAN SMITH: Why don't you take it?

MS. WEISS: That is fine.

MR. CUTCHIN: We will make those copies available as soon as we get them over here.

CHAIRMAN SMITH: Now, to explain our ruling, although we don't feel that we are always bound by the prefiled written testimony, as evidenced by the last panel of witnesses, and that we can substitute other confrontation

methods, we believe that this proposed testimony is too complicated to handle in the manner that we did with respect to the last panel.

Therefore, we will require that there be either prefiled written testimony or something that will achieve the functional equivalence, by giving the parties notice, and I don't know what that could possibly be, but we won't foreclose your ingenuity in coming up with something along that line.

MR. CUTCHIN: Do you have a date in mind on which the Board would like to have this witness come back and present this testimony? Both a date for the prefiling and a date to come back and hear the substance?

CHAIRMAN SMITH: Ms. Weiss, what would be your pleasure on that? Now, before you comment, look at what is being offered here.

MR. CUTCHIN: The substance, Mr. Chairman, if any, would really be reflected in the comments portion of this document over on the righthand side. All the lefthand column is just a listing of the recommendations. The action required is listed in the second column. The key to where it meshes with NUREG-0660, the implementation with the other documents. The licensee's response is a paraphrase of what appeared in the licensee's testimony. And then the staff's substantive response if you view it as that is in the

comments section.

The rest is just imparting information.

CHAIRMAN SMITH: I would imagine that the witness is not going to be able to testify in detail as to the merits of the comments, but merely explain what they are and that they are present.

MR. CUTCHIN: That is correct, and many times the outcome will be that there is not yet an implementation date established for responding to many of these recommendations, and I think there is not going to be as much substance there as some people think.

CHAIRMAN SMITH: Well, the Board needs guidance and I believe UCS needs guidance along this line too, and all of the parties.

MS. WEISS: I think that all we need is about a week, assuming that one of those is a free day in the office, after we have gotten the presentation, including the witness's qualifications on 0737.

(Pause.)

CHAIRMAN SMITH: The problem is, I just can't look forward to next week and identify a time where --

MR. CUTCHIN: You could tell us no sooner than such and such a date by when you would like to have the prefiled testimony. It will take him a day or so to put together a road map directing the reader through this chart,

and there won't be much in the way of additional substantive comment beyond what is in the comment column.

CHAIRMAN SMITH: Why don't you present that if it is possible to the other parties our first meeting day next week? Would that be enough time? That will give you the balance of this week. If you need more time, well, take it.

MR. CUTCHIN: That seems to be reasonable, Mr. Chairman. If we could have it next week. Tuesday is the first meeting day.

CHAIRMAN SMITH: I regret if the Board's remarks have caused you to bring Mr. Capra up here thinking that he would be available to testify. I was not aware that that is why he was here. I didn't even know that he was here. I hope you will feel free to test in advance your plans along that line in the future.

MR. CUTCHIN: We will do so in the future, Mr. Chairman. We are making an attempt now to be as responsive as quickly as possible to what we view to be an expression by the Board of the need for more information.

CHAIRMAN SMITH: Let me just give you some help on Mr. Capra's problems. We indicated Dr. Little is going to have to be away on another hearing next week, and she wishes to be present during Mr. Capra's testimony. So that would mean if you could have it -- if you could present his written testimony at the beginning of next week, there would

be little possibility of having him here as a witness until the 24th, and as we know, the 24th is still in doubt about what we are going to do on that day.

So, for his planning purposes, that is the earliest that he could be requested to testify.

MR. CUTCHIN: Thank you.

MR. TOURTELLOTTE: Mr. Chairman, I guess I need a little guidance from the Board, because I think as the Board can tell, what we have tried to do is to respond to Board questions as quickly as we can and as fully as we can. And as you can see, Mr. Capra was quite complete, and perhaps had a very lengthy answer to the Board's question. I am not really concerned about this instance as much as I am concerned about what happens in the next six months.

The question is, does the Board want us in responding to its questions to file written testimony in response to all the Board questions, or is this something that we are going to have to play by ear, or what?

CHAIRMAN SMITH: Mr. Tourtellotte, I would think that the standard should be that filed written testimony, prefiled written testimony be provided. However, I don't think that it was necessary nor appropriate for the witnesses that appeared today. It would have been nice if they had been, but it wasn't necessary, because I think that what they had to testify to was -- What the Board wanted was

something on the record and some explanation of the background which we were receiving this testimony.

The testimony was what I regarded as a rather neat presentation, and we can take the trouble, then, to put into place the substitute confrontation rights that the parties have. We can do that, but on something as complicated as this, I don't know how to work that out. That would be very hard to do.

So, my advice to you then is, when the Board indicates that it feels that more information is needed on a given issue, that we discuss each time how it should be handled. If it is simple, if we feel that it is amenable to other methods of confrontation by adversary parties, then we will make a ruling similar to the way we have with this other panel.

If not, I guess we will be bound by the prefiled written testimony, and of course it will depend on whether there are any objections, too.

Now, we would proceed this way without the objections of the Union of Concerned Scientists. We would proceed with him today absent objections by Ms. Weiss.

DR. JORDAN: That is right, but you see, you did have plenty of warning on this question. The question was circulated many months ago. And I think it is apparent to the staff and to the Board that Mr. Jensen did not reply to

the Board part of the question. He replied to the UCS 8 part of the question, but not to the Board part of the question. So therefore that is the reason why we are asking for written testimony on questions which we give you lots of warning. There are going to be plenty of times when we are going to say we need more information, come back tomorrow with it. That will be different.

CHAIRMAN SMITH: Are you ready, Mr. Cutchin?

MR. CUTCHIN: I am finished with this. Are you ready to call Mr. Jensen? I assume the Board has ruled.

CHAIRMAN SMITH: I think the sentiment amongst the parties is to wait until tomorrow. All right. We will begin.

MR. BAXTER: Mr. Chairman, just one closing matter in connection with the emergency planning meeting. Mr. Trowbridge asked me to announce that he has been able to get in contact with Mr. Zaylor, and licensee will be able to support a meeting during the week of the 24th of November.

CHAIRMAN SMITH: Okay.

DR. JORDAN: I am a little bit unclear. Tomorrow morning are you going to put on Mr. Jensen for the limited purpose of replying to UCS 8?

MR. CUTCHIN: That is correct, sir, and to the extent the Board wishes, to discuss and amplify his response to Board questions on UCS 8, unless the Board would rather

wait and hear all of it at one time when Mr. Capra comes back.

DR. JORDAN: I think that part will be all right, but I will not ask Mr. Jensen questions on the 0565, and that part of it.

MR. CUTCHIN: That will be suitable to us, Dr. Jordan.

Mr. Jensen will be available for whatever use we wish to make of him tomorrow.

MR. ROBERT ADLER: Mr. Chairman, I would just like to get a clarification on the emergency planning session, that Mr. Tourtellotte is going to contact all of the intervenors with emergency planning contentions and make sure that they can come on that day before he reports back to the Board?

CHAIRMAN SMITH: That isn't exactly it. What is your plan, Mr. Tourtellotte?

MR. TOURTELLOTTE: I did intend to try and contact all of them to find out what their conveniences were and then report back to the Board, and my understanding was that the Board then was perhaps going to issue an order.

CHAIRMAN SMITH: Yes, we don't regard it as merely a matter of convenience. We regard it as a very important matter which we will set aside time which otherwise would have been hearing time for required attendance.

MR. ROBERT ADLER: I understand that, and I agree. I just think that notice is very important, and an effort to accommodate them is very important, because I think if few or no intervenors come to the meeting, there will be very little point in having it.

CHAIRMAN SMITH: Well, it is very important that they come. I hope that you can give them as much notice as possible.

MR. TOURTELLOTTE: We are going to try to do that, I think probably in the morning.

CHAIRMAN SMITH: Because the fact that there is going to be such a meeting was made clear last Friday on the transcripts, and it was made clear in the order which is being served today. It is simply the date that is uncertain.

MR. TOURTELLOTTE: I think one of the reasons that we have sort of waited is that we wanted to be sure the order was out because it would't be -- I can't say there would't be any point. There would be less point if we had no order. So now that we've got an order, while we are trying to mobilize to get all the parties notified.

CHAIRMAN SMITH: The order was served today. It was served today?

MR. TOURTELLOTTE: Yes.

CHAIRMAN SMITH: All right. Anything further

before we adjourn?

(No response.)

CHAIRMAN SMITH: All right. We will meet then tomorrow at 9:00 a.m.

(Whereupon, at 5:11 p.m., the Board was adjourned, to reconvene at 9:00 a.m. of the following day.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

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in the matter of: METROPOLITAN EDISON COMPANY

Date of Proceeding: November 12, 1980

Docket Number: 50-289 (Restart)

Place of Proceeding: Harrisburg, Pa.

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

Alfred H. Ward

Official Reporter (Typed)

Official Reporter (Signature)