UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMSSION

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In the matter of:

METROPOLITAN EDISON COMPANY   Docket No. 50-289 (Restart)

(Three Mile Island Unit 1)

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25 North Court Street,
Harrisburg, Pennsylvania

Thursday, November 20, 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

Also present on behalf of the Board:

MS. DORIS MORAN,
Clerk to the Board

APPEARANCES:

On behalf of the Licensee, Metropolitan Edison Company:

THOMAS A. BAXTER, Esq.
DELISSA A. RIDGWAY, Esq.
GEORGE F. TROWBRIDGE, Esq.
Shaw, Pittman, Potts and Trowbridge,
1800 M Street, N.W.,
Washington, D. C.

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On behalf of the Commonwealth of Pennsylvania:

ROBERT ADLER, Esq.
Assistant Attorney General,
505 Executive House,
Harrisburg, Pennsylvania
WILLIAM DORNSIFE,
Nuclear Engineer

On behalf of Union of Concerned Scientists:

ELLYN WEISS, Esq.,
ROBERT D. POLLARD
Harmon & Weiss,
1725 I Street, N.W.
Washington, D. C.

On behalf of the Regulatory Staff:

JAMES TOURTELLOTTE, Esq.
JAMES M. CUTCHIN, IV, Esq.
Office of Executive Legal Director,
United States Nuclear Regulatory Commission,
Washington, D. C.

Petitioners for leave to intervene pro se:

STEVEN C. SHOLLY,
304 South Market Street,
Mechanicsville, Pennsylvania

C O N T E N T S

P R O C E E D I N G S

Whereupon,

JARED WERMIEL, W. JENSEN and E. LANTZ,

called as witnesses by counsel for Nuclear Regulatory Commission staff, having been previously duly sworn by the Chairman, resumed the stand, were further examined and testified as follows:

BOARD EXAMINATION

BY DR. JORDAN:

Q First I have a few general questions concerning the staff's philosophy on the question of safety of B&W plants following a feedwater transient, and the ability of the various systems to mitigate the consequences of a feedwater transient.

First of all, I gather both the Licensee and staff assume a feedwater transient is one of the expected transients that must be protected against, and the protection systems involved are primarily the emergency feedwater systems, the high pressure injection system or emergency core cooling system as you wish, and then finally the decay heat removal systems.

Does that in general represent the position of the staff?

Perhaps many of my questions will be addressed to Mr. Wermiel, but any of the gentlemen can answer. So would you keep the microphone in front of you, because I know you will be answering a great majority of my questions.

A (WITNESS WERMIEL) Yes, I think your characterization is generally correct.

Q All right. Now, then, I have been puzzled off and on, as has been apparent from the beginning of this hearing, as to whether the staff and the Licensee have had a consistent position on these various measures to mitigate the consequences, and the one that has been puzzling me most, I guess, is the emergency feedwater system, and the question has arisen a time or two, is the emergency feedwater system one of the engineered safety features, and therefore, must it be safety grade? And if that is the wrong word, tell me so. What word do you use for a system?

A (WITNESS WERMIEL) I would use the word engineered safety features for any system that is required to mitigate a particular design basis accident or transient, and in that context, I would say emergency feedwater is an engineered safety feature system. Our current practice is that an engineered safety feature system therefore is a safety grade system.

Q Fine. Fine.

I guess I was hoping that would indeed be the staff's position.

Now, then, what puzzles me, I guess, in the past the emergency feedwater system has not always been so considered.

Now, can you explain why that is, and is this -- has the change in attitude come about as a result of TMI or what?

A (WITNESS WERMIEL) The change -- in the past, I would characterize the auxiliary feedwater or emergency feedwater systems more as viewed as a system important to safety, and the criteria applied to its design were perhaps not as well defined or as stringent as they are today. There was in progress before TMI 2 in the context of the Standard Review Plan and other documents a gradual upgrading of auxiliary or emergency feedwater.

Q I see. This was going on before TMI 2.

A (WITNESS WERMIEL) Yes, yes it was.

Q Were new plants, for example, were construction permits required to have safety grade -- engineered safety -- safety grade emergency feedwater systems?

A (WITNESS WERMIEL) Yes. That was our intent, to have a safety grade or engineered safety features emergency or auxiliary feedwater system.

Q I see.

A (WITNESS WERMIEL) When exactly the feeling of this upgrade to safety grade to really occurred, I am not entirely sure. I do not know whether it was --

Q I don't think that is important. Fine, I see. All right.

A (WITNESS WERMIEL) Since TMI 2, though, there have been additional -- there has been an additional feeling for upgrading, particularly with respect to its reliability in the areas of its reliability.

Q Is it not apparent that the emergency safety features -- that the auxiliary feedwater system is a very important system in following a feedwater transient? It is the main heat sink for removing core heat.

A (WITNESS WERMIEL) That is correct. It is the system relied on to mitigate any consequences as a result of loss of feedwater.

Q Yes. Good. How -- and again, just as a matter of philosophy, how did it happen that this was not really recognized perhaps earlier? Can you speculate even on that?

A (WITNESS WERMIEL) Yes, I can speculate. In the past, our review -- this is the overall NRC review of accidents -- tended I believe to concentrate on the primary system, and direct emergency core cooling systems and the like.

Q Was it a feeling that the emergency core cooling system would really take care of anything?

A (WITNESS WERMIEL) Well, yes. I think we tended to concentrate a lot on things like the large LOCA, large break LOCA, and then we recognized a smaller LOCA could occur, but we could still mitigate that with the HPI system. I do not know that we were really thinking about long term core cooling with respect to the secondary side.

Q I am certainly not being critical of the staff or the Licensee in this respect because I must say that I myself was undoubtedly slow to realize the nature of this, and in the last few years I have become somewhat of an advocate of a dedicated heat removal system, and I think it is the thing that is going to come one of these days.

But on the other hand, I am not at the stage yet where I would say that you should not be licensing nuclear plants. I am by no means making that -- and I know the staff is not either, but as I say, my feeling has switched over the years, too, and it has always been my feeling that the most likely accident, and long before TMI, that the most likely accident would be a failure to remove afterheat.

Nuclear plants are unique and different from coal plants in that you can shut down a coal plant but you cannot shut down a nuclear plant. Some of our systems, by the way, I have been involved in design of controls and systems for research reactors, including the MTR. It was our intent, then, to make the removal of heat after shutdown as completely reliable as possible. And in this regard, by the way, one of our feelings is that a system that is operating is probably the most reliable system, and in fact, one case where the design of the system -- the system required exceedingly high reliability electrical power, we went to diesels, of course, but we used the diesels for the main system so that if there was any doubt when the diesels failed, then the backup system was the more reliable system, namely TVA power. But rather than using diesels for backup, we did it the other way around, and I believe you do improve reliability.

And this was touched on a little bit yesterday when Mr. Pollard brought up the fact that if you use a system for startup and shutdown, it does give you more tests and more chances to see it operate. So there could even be a case made for having the emergency feedwater system operating full time. But it isn't that way, so let's now go into the question, is the emergency feedwater system adequate and reliable, and I think I will have a fairly lengthy set of questions to you concerning this.

Now, I notice you sometimes do speak for the staff in giving the staff's position.

Now, would you say just how this comes about?

Are you able to say, for example, that the staff believes, for example, that the emergency feedwater system is adequately reliable in B&W systems? You cannot surely be expressing the view of the entire staff. There must be other people with different opinions now. So how is it you speak for the staff?

DR. JORDAN: Mr. Baxter I know is anxious to say something. Please do.

MR. BAXTER: One point of clarification. At the end of you question it implied that emergency feedwater systems are part of the B&W design and part of the B&W NSSS, which is my understanding they are not. They are not designed by Babcock and Wilcox. They are designed by the individual site architect engineer to meet B&W's criteria.

DR. JORDAN: This is not part of the package, then, of the steam supply system, and I had not realized that.

MR. BAXTER: So there are differences.

DR. JORDAN: Yes, yes, I appreciate you pointing that out because you are exactly right.

BY DR. JORDAN: (Resuming)

Q All right. And so therefore I do notice that there is a table in the NUREG reports comparing the various systems, and it does of course make differences.

I notice Davis-Besse, for example, there are differences among the various systems, and you point out something that is certainly correct, but I just had not thought of it that way, so that I better not refer therefore to B&W systems, excepting that B&W systems I guess all do

have the once-through steam generator, isn't that right?
A (WITNESS WERMIEL) That is correct.
Q I see. Very well.
And it was the opinion of the staff that this -- and the Kemeny Commission and others that this did result in a more sensitive system, a system that required more certain and quicker response from the operators and the mitigating systems, and I do not think I need to ask you your opinion on that. I believe this has been documented.
Now, then, let's go back to the question. How is it, for example, that you are able to say the loss of emergency feedwater following a main feedwater transient is not an accident which must be protected against with safety grade equipment?
Now, is this your opinion, is this the staff's opinion? Is it everybody's opinion in NRC or what?
A (WITNESS WERMIEL) It is the overall staff opinion that any safety grade system is not subject to total failure, only a single failure. We do not postulate the total loss of a system that is classified safety grade.
Q No matter how poor the design is? No matter how poor the design is, if there are two -- if it meets those criteria?
A (WITNESS WERMIEL) That is my understanding. The very fact that it is safety grade in our minds means that it

is not a poor system, that the criteria to which it has been designed are adequate to assure its reliability and operability.

Q Well, perhaps the weasel word then is the criteria, that the staff continually upgrades the criteria if they feel it is not adequate to meet -- is this the situation, that the criteria continually are changed, or are you relying on the General Design Criteria, and that is it?

A (WITNESS WERMIEL) No, it is more than just the General Design Criteria. We have a specific application of the General Design Criteria and I think that application does evolve and change as we learn more, and -- from various -- in various ways from tests, say, at the LOFT facility or things like that, Licensee reports, reliability studies, things like that.

Q Do you have any feeling, of all the engineered safety features, are they all equally reliable?

A (WITNESS WERMIEL) I have absolutely no feel at all.

Q You have no feel at all? You would say that the emergency feedwater system, for example, or the diesel generator systems are equally as reliable as the protection systems?

A (WITNESS WERMIEL) I would not say they were equally reliable. I do not know that we have analyzed the reliability of individual systems. We have analyzed the reliability of some auxiliary feedwater systems. I think there are inherent features of certain types of mechanical components that make them maybe more or less reliable.

Q So you say you have analyzed the reliability of auxiliary feedwater systems?

A (WITNESS WERMIEL) Yes, we have.

Q Are you going to present that in this case as evidence?

A (WITNESS WERMIEL) I do not know whether the --

Q I see. You don't think it is necessary.

A (WITNESS WERMIEL) NUREG-0611 and 0635, and then the B&W reliability reports are --

Q Do you claim the B&W reliability report analyzes the reliability? I mean, the B&W report.

A (WITNESS WERMIEL) What it does for certain postulated events, it attempts to rate or to categorize these particular plants into an array to establish a relative feel for where they stand.

Q So they could be all bad or all good.

A (WITNESS WERMIEL) Relatively speaking, yes.

Q see.

A (WITNESS WERMIEL) We had no goal in mind. We do not know what constitutes a reliable system. We were trying to find out where we can make improvements based on what we learn in this fashion.

Q All right. Now, you speak for the entire staff in saying this?

A (WITNESS WERMIEL) I am speaking for myself. I cannot say what other people have in mind. I only know what I have seen and what I have done.

Q Do you know any studies at all that have been taken -- that are being undertaken by the reliability analysis group -- I was trying to recall the name of the man from TVA who recently came.

MS. WEISS: Michaelson.

BY DR. JORDAN: (Resuming)

Q Has Michaelson looked into this at all, do you know, and what has he found?

A (WITNESS WERMIEL) I do not know that he has. I know we have a staff at NRC that does look at it and do reliability analyses and reliability work.

Q But it is not important to your job of deciding whether the system is adequately reliable. You can say -- I believe you say it is reliable, and --

A (WITNESS WERMIEL) In the current context that we use reliability studies, I guess we have determined that we think it is reliable. Whether or not there will be additional work in this area I am not sure. And whether this additional work will be applied in our safety reviews, I just do not know.

Q Are you familiar with the staff studies and work over the past few years on ATWS, that is A-T-W-S?

A (WITNESS WERMIEL) I am not very familiar with ATWS at all, no.

Q Are you aware that the protection system must be a safety grade system? By the protection system now, I mean the system that detects over -- excess power above a certain level and calls for the scram and other actions. Now, is this built onto safety grade criteria?

A (WITNESS WERMIEL) I am not aware.

Q You are not aware.

A (WITNESS WERMIEL) About ATWS at all.

Q None of the others?

A (WITNESS LANTZ) No.

MR. CUTCHIN: Dr. Jordan, we will have a witness coming up on the next item who is very familiar with protection system criteria.

DR. JORDAN: I am very familiar with protection system criteria.

MR. CUTCHIN: But if you were interested in getting an answer that was evidence --

DR. JORDAN: No, I am not interested in getting an answer. I am trying to find out what these folks understand about reliability in order to be making the conclusions that they are.

MR. CUTCHIN: I think, Dr. Jordan, I am not sure this will help you, but the staff, as I believe you are aware, in deciding on the adequacy of the design of the emergency feedwater system judges it today against the criteria set forth in SRP 10.4.9. Then there are others who are doing long term studies to look at the need for further improvements, as has been said here. But today, for this plant, as well as for others, compliance with the current criteria is viewed by the staff to provide a sufficiently reliable system for operation today. That is not to say that they are not always looking for the need for further improvements.

DR. JORDAN: It is your interpretation, then, of the Commission's order that sufficiency is determined by meeting past criteria?

MR. CUTCHIN: No, that is not necessarily my interpretation, sir. I look at this particular Commission's order to give this Board the authority to inquire into that and to make whatever recommendations it believes are appropriate to the Commission.

DR. JORDAN: All right.

CHAIRMAN SMITH: That does not exactly answer Dr. Jordan's question. However, we understand what our authority is. He was wondering what the staff's position is.

MR. CUTCHIN: I will have to defer to the witness, but my understanding is they are judging these systems today against these criteria, and are requiring prior to restart the kinds of upgrades that grew out of 0578 and other places in the short term, and it is indeed, I understand, the staff's position that compliance with those short term recommendations which were indeed staff recommendations, provide sufficient reliability to allow the plant to restart.

DR. JORDAN: Okay. Well, we will have to go into it then.

I guess the staff has been very selective in their criteria, so apparently there is a great deal of judgment involved in what criteria will be chosen and what will not be chosen, and I will be going into some of the recommendations of some of the staff's documents and asking you whether you believe that those recommendations should be implemented or not, and why not.

BY DR. JORDAN: (Resuming)

Q And were you members, by the way, of some of these task forces that were involved in the writing of documents, such as NUREG-0560, the generic assessment for B&W reactors, or the NUREG-0667, transient response of B&W design reactors?

A (WITNESS WERMIEL) No, I was not.

A (WITNESS LANTZ) No.

A (WITNESS JENSEN) No.

Q All right.

(Pause)

BY DR. JORDAN: (Resuming)

Q Let me first turn to a document that was just issued a few days ago, dated October 21, 1980, Seismic Qualification of Auxiliary Feedwater Systems. It is a letter to all operating pressurized water reactor licensees and signed by Darrell Eisenhut. I think we all received it. There is just one sentence out of it which is all I am going to look at. It says, "Since the TMI accident, we have been reviewing AFW systems for all operating PWRs to assess the need to backfit design and procedural modifications. Our review has been based on a deterministic evaluationk primarily against the SRP" -- that is, the Standard Review Plan -- "in conjunction with a reliability study using event and fault tree analyses to determine dominant failure modes."

Now, what I am asking of you, would you please describe these reliability studies using event and fault tree analyses to determine the dominant failure modes?

A (WITNESS WERMIEL) Fine. The B&W reliability analyses that were previously referenced do contain event -- well, they contain fault trees for the particular system.

Q Yes.

A (WITNESS WERMIEL) And these fault trees are applied to the three postulated events. From these fault trees, the dominant failure modes were then established and documented, and we have attempted to address them in our upgrades of these systems.

Q Good.

A (WITNESS WERMIEL) A similar technique was also performed on the Westinghouse and CE plants.

Q But the Westinghouse and GE plants --

A (WITNESS WERMIEL) CE.

Q Westinghouse and CE plants.

A (WITNESS WERMIEL) Combustion Engineering.

Q Studies were put out under the staff aegis, and presumably therefore had staff review, or do they again in those cases just take the licensee's --

A (WITNESS WERMIEL) The NUREG-0611 and 0635, and associated reliability studies referenced in them were performed by the staff and staff consultants. In the case of the B&W plants there as a meeting with the B&W owners group at which time it was decided that B&W would perform the reliability analyses and NRC would review it.

Q Can you tell me the extent of the NRC review and the results of the NRC review?

A (WITNESS WERMIEL) The NRC review was performed by the probabilistic analysis staff. I have seen a draft of the results of that review, and that draft concurred in the methodology that B&W used when they did the reliability analysis and confirmed the recommendations for improvement in reliability based on the identified dominant failures.

Q I see. They agreed, then, that the B&W plants were in general more reliable than the other plants. I believe that is what the B&W study shows.

A (WITNESS WERMIEL) No, it doesn't, I don't believe, at all. I believe the B&W study shows, with the disclaimer identified in Appendix B, that the B&W plants, their auxiliary feedwater systems, tend to fall in the mid range of the Combustion Engineering and Westinghouse plans.

Q And the staff agrees. The reliability staff looked at that and agrees --

A (WITNESS WERMIEL) Under the assumptions B&W used, we generally concur in that recommendation. There are differences, I believe, identified by the Licensee in certain approaches taken by B&W and taken by the staff.

Q All right.

The Licensee has said that they do not believe a common mode failure is a dominant method, that they believe component failure was the dominant failure mode, and this was presented here, and the staff agrees with this?

A (WITNESS WERMIEL) I am not sure I quite understand if that is exactly what the Licensee said. My understanding of what is dominant is a single failure source in a component. That is the dominant --

Q The staff believes that the dominant mode of failure is a single failure.

A (WITNESS WERMIEL) That is correct. Then there are other common mode failures that once you have eliminated the single failure sources would be the dominant point of unreliability, particularly those common modes associated with humzn error or the operrator.

Q I see.

So then you do agree with the Licensee that failure of component is the dominant failure mode.

A (WITNESS WERMIEL) Yes, I believe that is what these reliability studies have intended to point out.

(The Board conferred.)

BY DR. SMITH:

Q Mr. Wermeil, you referred to a disclaimer in the appendix of the report.

Would you describe that more thoroughly, please?

A (WITNESS WERMIEL) Yes. I am referring to BAW 1584, Appendix B. I believe one of the examples is identified as differences in approach. It is with respect to the half capacity pumps, and I believe that was pointed out by the Licensee. B&W in their study assumed that both half capacity pumps were required for mission success. In the NRC reliability evaluations, mission success was accomplished in, I don't know whether it was all of them, but in a large number of the Westinghouse and CE plants with only one of the half capacity pumps, and when you apply that same reasoning to the B&W design for TMI 1, you do get improvement in its placement relative to where it stands now.

BY DR. JORDAN: (Resuming)

Q So the staff reliability then would credit it with higher reliability.

A (WITNESS WERMIEL) Yes. I think B&W points that out, that the staff would tend to show some slightly higher reliabilities for the Westinghouse and CE pumps.

Q Didn't you say as part of your testimony that common cause failure mode as a result of operator error still remains as the dominant source of system unreliability?

A (WITNESS WERMIEL) Yes, I think I did.

Q How does that square with your saying a moment ago that you felt that the single failure criterion was the dominant source of unreliability?

A (WITNESS WERMIEL) I believe the context of my statement was that once you have eliminated the single failure sources, then this becomes the dominant source.

Q What else is there, in essence?

A (WITNESS WERMIEL) There are other potential common mode type failures.

Q I see.

A (WITNESS WERMIEL) Certainly an environmental effect would be a common cause failure.

Q A what, a common cause -- yes, yes.

Have you seen the IREP study, I-R-E-P, on Crystal River?

A (WITNESS WERMIEL) No, I have not. I do know that there was one performed.

Q All right.

A (WITNESS WERMIEL) I also believe there are others either under way or being planned.

(Pause)

Q Can you assure me that the IREP study or any study performed by the reliability group, Mr. Michaelson's group, would agree that a single fa. 'ure is the dominant mode as compared with common mode failure?

I guess I am questioning what I believe the staff cannot be -- it seems incredible to me at the moment anyhow that the NRC staff's positin --

A (WITNESS WERMIEL) I believe Mr. Lantz --

A (WITNESS LANTZ) The LER data substantiates that by a big margin. You can see it from the LER data.

Q I guess in my looking at the LER data I reached exactly the opposite conclusion.

A (WITNESS LANTZ) Well, you do not have the data on the single failures. The large majority of the LER data is single failures.

Q Oh, well, you say -- well, maybe I am beginning to understand, then. I am talking about the dominant failure mode for the entire system, not the dominant failure mode for one component. I mean dominant failure of one train.

Now I am beginning to understand, of course, if that is what you meant.

A (WITNESS WERMIEL) No, I think I was speaking of it with respect to the entire system, and I don't know that it is documented anywhere that this is the case. But we do identify points of a single failure source as being very important and then address them accordingly and try to deal with them.

Q But now, then, doesn't this mean that you have to have simultaneous single failures in two trains in order to get failure of the system?

A (WITNESS WERMIEL) No, not necessarily. In the case of the ICS interface with thue flow control valves, for example, a single failure, I believe, there is a single failure mode within that particular component that would temporarily leave both valves closed.

Q I see.

So you are saying that failures outside of the system, single failures such as a fire or a short of the cables or something like this would be a dominant mode.

A (WITNESS WERMIEL) I would characterize a fire as a common cause failure, since it could affect both trains.

Q All right. Then tell me. You mentioned one, the IREP, the Integrated ICS, the Integrated Control.

A (WITNESS WERMIEL) There are other examples I can think of, cases where suction supplied to the pumps is provided through a line with a single valve in it in certain plants. If that single valve is left closed inadvertently for some reason or whatever, then you do starve all auxiliary feedwater pumps for suction supply, and that can consequently cause a failure of the whole system. And we are addressing that in the plants that have that particular design.

Q Do you call those single failure modes?

A (WITNESS WERMIEL) I believe that is how they have been characterized by the reliability analyses people, as a single failure source.

Q I guess I am a little skeptical of your definition of single failure. Do we need to start looking at what is meant by looking at single failure criteria?

A (WITNESS WERMIEL) Yes, I was just going to say I think maybe the single failure as applied in reliability is maybe interpreted differently than it is applied in the safety review.

Q All right.

A (WITNESS WERMIEL) I am beginning to see that perhaps from our discussion. I had not really thought of it before, but certainly the single failure that was identified in the ICS was in the same fashion, but perhaps the valve I mentioned might be viewed as a common cause in certain cases. It may be just a matter of semantics.

Q But now, then, you are saying that the reason the emergency feedwater system, one of the reasons -- the reason it is judged to be safe is it meets the criteria for safety systems.

A (WITNESS WERMIEL) And in addition, we have addressed other points of unreliability that may not have been picked up by the criteria in the SRP as a result of this reliability analysis.

Q I guess this raises a number of questions, and I will not be able to keep them all in mind.

Are you saying that now it is necessary to go beyond the SRP in order to -- and the General Design Criteria in order to decide whether the system is adequately reliable?

A (WITNESS WERMIEL) I think we recognized that we have learned a lot from the reliability study that was not necessarily part of our previous review. This single valve I speak of, for example, in the past it is an always open locked valve, so we never assumed it to fail, but now when you look at it with respect to reliability and potential for an error by the operator or some other means, it becomes a problem or something we feel should be addressed.

Q I think you and I are approaching maybe a little bit better understanding, because to my mind, that would have been a failure outside of the system itself, and I would have called it common mode failure. But I guess --

A (WITNESS WERMIEL) It is not a single --

Q It is not a single failure in the sense that the single failure criterion as usually expressed in IEEE 279 --

A (WITNESS WERMIEL) That is correct. It is a little different.

Q All right.

Now, then, we are making progress.

You agree that there are other failure modes which are not even included in the single failure criteria which must be addressed, and that the staff has addressed these other things, and that these have come about because of reliability studies.

A (WITNESS WERMIEL) Yes, definitely. I do not think there is much attention -- in the past I don't think there was much attention paid to the potential for an operator error, and reliability studies definitely point this thing out with resulting improvements in procedures and tech specs, and in that aea.

Q Yes. Okay. Fine.

But now I think perhaps we are arriving again at, let us say, the staff position. The staff position then is that the emergency feedwater system -- and I may end up -- we will be talking about more than just the emergency feedwater system because I am really concerned about the main feedwater transient protection, and there are other mitigating systems, too. But at the moment, the emergency feedwater system was judged to be adequate and reliable because, first of all, it did meet the criteria, GDC 44, among others, it met the requirements of Standard Review Plan 10. -- would you fill in the numbers?

A (WITNESS WERMIEL) 10.4.9.

Q And it also met additional requirements stemming from reliability studies.

A (WITNESS WERMIEL) That is correct. I am sorry if I confused you in the past.

Q Okay, yes, yes. No, I am really trying to pin you down as to exactly what is involved in your statement that it is adequately reliable.

A (WITNESS WERMIEL) I think we tried to outline this whole approach in the restart SER. I do not know if we did a good job or not, but that was essentially what we were trying to indicate, I think.

Q The restart SER is a fairly compact document, and it is impossible for you or anyone else to say all the things you have said this morning, even -- there is no way.

A (WITNESS WERMIEL) I couldn't have gotten it in there.

Q But now I gather you arrive at this, that it does meet the riteria, the recommendations of the Standard Review Plan, recomendations resulting from the analysis of the Crystal River, TMI accidents and so forth, other recommendations that have been made and agreed to by the staff, some of those, anyhow.

A (WITNESS WERMIEL) Yes. There were a number of other recommendations that were made as a result of Crystal River, I believe in Document NUREG-0667, and I do not think we have addressed those yet. I do not know what the schedule for implementation of that is.

Q We are going to get to those recommendations.

A (WITNESS WERMIEL) Some of that I think has been addressed.

Q We will get to those.

A (WITNESS WERMIEL) Okay.

Q But it still -- is it a matter of engineering judgment on the part of the staff that it is adequately reliable rather than have a demonstration of reliability from the standpoint of a numerical goal?

A (WITNESS WERMIEL) That is correct. We have no numerical goal at this time.

Q All right.

(Pause)

BY DR. JORDAN: (Resuming)

Q Let's, however, despite the fact you do not have a numerical goal, let's consider the past reliability of the emergency feedwater systems. I believe you identified something like eight or nine failures of the emergency feedwater systems when challenged, and something on the order of 200 reactor years.

Who was this?

A (WITNESS WERMIEL) Mr. Lantz did that.

Q All right. So that the numbers are close enough and it is not a matter of quibbling, 8 out of 200 is the order of 1 out of -- what is it, 25? The past reliability indicated about once out of 25 as the emergency feedwater system reliability.

A (WITNESS WERMIEL) That is on a per reactor year basis.

Q Per reactor year basis.

Now, is it the staff's position that a reliability in a redundant system that has a failure rate of one out of 25 is adequate?

A (WITNESS WERMIEL) I do not know.

Q As long as it meets the criteria, that is all that is required is this --

A (WITNESS WERMIEL) Up to this point, and at this time that is my only basis of judgment. Whether or not that type of reasoning gets applied in the future, I do not know.

BY MR. SMITH: (Resuming)

Q It has to be assumed that once during the operating life of the reactor that the event will occur.

A (WITNESS WERMIEL) Certainly the reactor will last at least 25 years.

BY DR. JORDAN: (Resuming)

Q All right, now, you are familiar with the St. Lucie decision. Which one of you --

A (WITNESS WERMIEL) I wrote the answer to part 6K, I think.

Q And you said essentially that the appeal board was wrong.

A (WITNESS WERMIEL) I do not know I said they were wrong.

Q I can hardly interpret it otherwise.

A (WITNESS WERMIEL) What I am saying there is the source for the number that they assigned I believe the number itself came from a document that is not meant to be applied to operating systems within the plant. It was meant to be applied --

Q We will get to that in just a moment.

A (WITNESS WERMIEL) Okay.

Q That is the reason why they are wrong. It must be that.

A (WITNESS WERMIEL) That is -- yes, that is my understanding. That is part of, I guess, a misinterpretation by the Board.

Q Now, this error by the appeal board, how will this be rectified? Will this be reviewed -- has this been reviewed by the Commission yet?

A (WITNESS WERMIEL) I don't have any idea.

DR. JORDAN: I ask the staff lawyer, has this decision been reviewed by the Commission?

MR. CUTCHIN: Sir, I do not know what the status of ALAB 603 is.

DR. JORDAN: You were not expecting any questions on this today?

MR. CUTCHIN: Not for a legal --

DR. JORDAN: I see. I think it is going to be very much a legal matter.

MR. CUTCHIN: That particular decision, if I recollect it, it went to a matter totally different from the reliability of feedwater systems. It went to the reliability of the grid.

DR. JORDAN: It went to the reliability of diesel generators which they said had a reliability of something like 10^{-3} or 10^{-4} per reactor year, very much more reliable than the reliability figures we are now talking about here.

MR. CUTCHIN: I am not sure we have talked about an absolute reliability level here, sir.

DR. JORDAN: Yes, the only reliability level we have at the moment is the reliability based on past experience.

Now, if there is evidence that that is entirely wrong, then I would be swayed, but I guess lacking such evidence --

MR. CUTCHIN: I hate to get into a legal argument with you, sir, but I think what you are doing here is assuming that because you have a failure rate of 8 out of 200 reactor years in systems that existed as they existed prior to improvements of the type that have been made since that time, that that data is still statistically meaningful. I do not know what the answer is with respect to whether we believe that number would be greatly changed. I doubt it has been greatly changed, but I do not know that that data is indeed statistically reliable.

DR. JORDAN: Possibly it has, and if it has, then great, I would love to see those.

MR. CUTCHIN: But your concern then is --

DR. JORDAN: That we are now depending upon redundant systems with a reliability of something like 1 in

25 per reactor year for protection. Past experience without adequate demonstration that the reliability is indeed greatly improved.

Now, if that was the case I would want to listen.

Now, Mr. Baxter would like to address this.

Mr. Baxter.

MR. BAXTER: I don't know that I can address the improvement, but we did have testimony by Mr. Kermiel yesterday at least that of the four data points that are described in their testimony, two of those failures could not occur at TMI 1, and that the majority of those were in systems which were used for auxiliary startup and shutdown of the reactor.

So it is not clear to me at all we have a failure rate from history that applies to this.

DR. JORDAN: It is not clear that the failure rate at TMI would be so high, that is true. But I just do not see any sound evidence -- you see, we are just entirely in the wrong ballpark is what I am worried about.

CHAIRMAN SMITH: Let's have the failure rate.

DR. JORDAN: Make it a tenth as much.

MR. BAXTER: Excuse me?

CHAIRMAN SMITH: Just for the purpose of inquiry, as a basis for Dr. Jordan's inquiry, let's assume a more favorable failure rate. Let's assume one in 50 years.

MR. BAXTER: Mr. Capodanno testified that we had ten manual actuations at TMI 1 and we had no failures.

CHAIRMAN SMITH: The record is not closed. The record is open on the determination of the reliability of the emergency feedwater system at TMI 1. In the meantime, Dr. Jordan is inquiring based upon some information he has in the record. He is going to and he should.

DR. JORDAN: Mr. Baxter, let me say with respect to the ten tests. I discount that almost entirely. I do not believe it demonstrates anything so far as operational experience is concerned because that is the way tests work.

WITNESS WERMIEL: I would point something out, if I could. The failure rate for diesels that you point out as a basis is a theoretical basis. There has not been a reliability study that I am aware of such as we cite here for auxiliary feedwater systems. I do not think there has been an LER search such as has been done here to come up with a comparable failure number.

DR. JORDAN: I am sorry, I disagree with you. I can quote some articles for you, a study that has been published recently in the Journal of Nuclear Safety on the failure rates of diesels, and it is pretty bad, I assure you. The actual experience in use, when called upon, is not good.

MS. WEISS: Dr. Jordan, before we left the subject, since everybody else has said something with regard to the applicability of the historical failure rate data, I just wanted to point out that this witness has testified that it is his opinion that the system will not be greatly improved upon conversion to safety grade.

MR. CUTCHIN: Dr. Jordan?

CHAIRMAN SMITH: With respect to the system as it exists, with respect to itself, not systems in general, Ms. Weiss, I think was his testimony.

MS. WEISS: This -- well, yes.

DR. JORDAN: Yes.

MS. WEISS: It is premature to artue.

DR. JORDAN: What you said is significant. I think it is relevant. So that is right.

Well, the improvements we will get into, but how significant they are from the standpoint of reliability, I think -- well, I guess I am almost inclined to agree with some of the people that improvements on some of the environmental effects, if they are rare events, would not result in a significant improvement in overall reliability. On the other hand, when we are dealing with a system which is challenged at the rate of three per year, and feedwater transients, according to the staff documents, occur in B&W systems at th rate of 3 per year.

BY DR. JORDAN: (Resuming)

Q Do you agree with that?

A (WITNESS WERMIEL) I have seen that, yes. That has not been the operating history of TMI 1, however.

Q All right.

A (WITNESS WERMIEL) TMI 1 has not had anywhere near that type of operating history.

Q What is the failure -- what is the frequency of feedwater transients at TMI 1?

A (WITNESS WERMIEL) I do not know that TMI 1 has actually experienced a single total loss of feedwater transient in its entire history.

Q How about TMI 2? How about there?

A (WITNESS WERMIEL) We had the one.

Q Is that all there has been in all the years of operation of TMI 1 and 2, just a single --

A (WITNESS WERMIEL) That is my understanding.

Q -- failure of the feedwater.

A (WITNESS WERMIEL) That is my understanding.

Q Very well.

But even so, I would not -- if it is true even, I would not necessarily consider it significant because one out of ten is not a very significant number when it comes to a statistic, statistical estimate of probability. So I do not think it is very convincing.

Well, now, with respect to staff's position on reliability, you say that numerical goals themselves -- you say the appeal b ,.a was wrong in taking as a numerical goal the 10^{-6} or whatevei, that that is not a staff goal for internal sys' .

A (WITNESS WERMIEL) That is correct.

Q Now, I don't know how to get at this, but I have follcwed very closely over the past several years the staff's analysis and requirements with respect to protection systems. There have been in something like 500 years of commercial operation of protection systems 1 ATWS event. The staff has argued, and I must say in contrast to the manufacturers, that that has statistical significance, and that the ATWS, the protection systems either have to be improved, because that would be -- they would claim that is a maximum reliability of something like 10^{-4} per reactor year. The staff says that is not good enough. Their goal is 10^{-6} for protection system reliability, and that they either must improve the reliability or put in mitigation systems to handle it. That seems to me a clear case where the staff is indeed setting a goal for an internal system and requiring changes of nuclear plants, all kinds of nuclear plants to meet a reliability goal of 10^{-6} overall, they feel would be mitigating systems, and I believe it may indeed in the case of TMI require an additional safety valve to relieve the pressure in case there is an ATWS, so that an

ATWS event would have a failure rate so far as meltdown is concerned, or a Class 9 accident, of less than 10^{-6}.

Now, you are not familiar with this. On the other hand, I say to you that this is a staff position, and it seems to be entirely inconsistent with what you are saying now about emergency feedwater systems.

A (WITNESS WERMIEL) All I am saying is I was not aware of that, and I am not aware of any goal, numerical goal applied to the emergency feedwater system.

Q With respect to emergency feedwater systems, you may well be right. I would say isn't this, then, a major error that has been uncovered? The appeal board has pointed out that it is not enough that we have a redundant system meeting the single failure criterion if that system itself is not reliable, and I want to point out to you some of the language. The appeal board does quote the staff criteria with respect to the single failure standard, and I am going to read a little of that.

I will read the entire paragraph, and this is now page 41 from the ALAB, A-L-A-B -603 in which they say, "As we explained in our order of May 3, the single failure standard appears in Commission criteria which according to their own introductory terms, one, are incompletely developed; two, establish only minimum requirements; and three, reflect the expectation that additional or different criteria will have to be identified and satisfied in the interest of public safety in unusual situations." They go on, "For the reasons cited above, we conclude that the circumstances present here call for such additional measures. The diesel generators employed for emergency onsite power can only be characterized as relatively unreliable pieces of equipment. Blind reliance on the single failure criterion, that is, simple redundancy, does not provide an adequate degree of plant safety and public protection in this state of affairs."

They go on, "In short, the probability of a complete loss of AC power is in the range of 10^{-4} to 10^{-5}. It is therefore unacceptably high relative to accidents and other events considered incredible for design purposes which have a probability no greater than 10^{-6}."

Now, as I say, this was on the basis of a criteria of diesel systems with an established record of better than 10^{-2} per year anyhow, overall, and they claim -- they say -- they refer here to figures of 10^{-3} to 10^{-4} to 10^{-5}. It seems to me that in view of the fact that the emergency feedwater system is such an important system, that we must have some basis for believing that the probability of successful operation when challenged must be surely much less than 1/25 per year, particularly when they are being challenged on the average at a rate of something like three per year.

Now, as I say, in contrast to the protection system which is being challenged once in 500 reactor years, this was before the Browns Ferry event, as being an unacceptably high rate, so if the appeal board is wrong, then we need somehow to have that demonstrated to me.

(The Board conferred.)

BY DR. JORDAN: (Resuming)

Q It is easy to get mixed up. As the Chairman has pointed out to me, something that I have myself caught a time or two, it is per demand failure of 10^{-2} per year, failure rate per year; since the demand in the case of blackout is fairly low, the overall failure rate per year was somewhat, therefore, less.

Now, here we are dealing, in contrast, however, with a demand rate of 3 per year and a failure rate of 1/25, which would by simple multiplication be 3/25 per year, about 1/10th per year, which is, to my mind, if the figures are right, is an intolerable situation.

MR. ROBERT ADLER: Dr. Jordan, we are having a lot of trouble correlating your use of units and the correlation between failures per reactor year and failures per demand in the system. It seems to us that it is more appropriate to use failures per demand on the system than per reactor year.

DR. JORDAN: It may well be, but on the other hand, the Commission's criteria are expressed in failures per reactor year. Their goals for systems outside of the internal systems, as was mentioned, is 10^{-6} per year, and the number that you get per year, it depends upon the demand rate as well as upon the failure rate.

MR. DORNSIFE: When you are looking at overall risk, you cannot multiply two units together. You multiply -- you cannot multiply the number of failures per year of main feedwater times failure rate of demand, and in this case, the failure rate per demand may be a factor of ten less.

DR. JORDAN: True. All right.

MR. DORNSIFE: That is the point we are trying to make.

DR. JORDAN: You have a point.

Would you try to express for me, then, a rate per year -- how would you arrive at it?

MR. DORNSIFE: I don't know. Maybe the witnesses could express their failure rate per reactor year in terms of failure rate per demand. I do not know.

DR. JORDAN: All right. I guess if the witnesses would like to do this -- I see a reluctance on the part of the witnesses to get into failure rates, but if they would like to express it in terms of failure rate per year, that would be fine. I would like their numbers.

WITNESS LANTZ: I cannot do that for you.

BY DR. JORDAN: (Resuming)

Q Well, my numbers may be wrong. I expect to be corrected if so. But I think there is just no question about the -- we are talking about different orders of magnitude than we are talking about in the case of protection systems, scram systems, and for which the NRC staff has already expressed their unhappiness.

Now, the appeal board, let me say now, this is not the end of the story. The appeal board did not say that St. Lucie was inadequately safe. They pointed out -- and here the parallel is very good -- they pointed out that even though there was a failure of the diesel systems, that the plant could stand a diesel failure if it was repaired on the order of three hours, I believe, and so therefore they should take that into account. And then I believe that there was testimony presented that if they did take into account the possibility of getting the system back in and there were estimates made of how quickly they could do that, then the overall system rate was a tolerable rate.

And we have now a somewhat similar situation here. We have the backup, the mitigation of the high pressure injection system which gives us some time to repair the emergency feedwater system, but this has not been considered, and as I say, what to my mind, this amounts to failure modes and affects analysis, and overall demonstration that the system on the whole will perform adequately safe. But in view of the appeal board situation, if I reject your reliance on the criteria, as I do at the moment, then there is still a possibility of a demonstration that the overall safety criteria are being met. And in essence, I kind of leave it there, that I need either a demonstration that the appeal board is wrong or that the overall criteria -- that the overall system reliability is high enough, that there is good reason to believe that the safety of the public is adequately protected. And I find it missing here at the moment.

Yes?

A (WITNESS LANTZ) If we take your numbers and we say .04 failures per reactor year, and just for purposes of demonstration we use three demands per reactor year --

Q Yes.

A (WITNESS LANTZ) And you have to divide, so the number comes out like .01.

Q All right.

A (WITNESS LANTZ) Failures per demand, right?

Q Right. Okay.

A (WITNESS LANTZ) And that is very -- that is like 1 times 10^{-2}, which is very similar to --

Q 10^{-2} per year.

A (WITNESS LANTZ) Yes.

Q Per demand or per year?

A (WITNESS LANTZ) Per demand.

Q Then you have to multiply that by 3 to get per year, if there are three demands per year.

BY MR. SMITH: (Resuming

Q What do you end up with?

A (WITNESS LANTZ) It would be .03.

DR. JORDAN: .03 per year failure rate.

CHAIRMAN SMITH: Per year.

DR. JORDAN: We are quibbling now over small numbers. We are so far from the 10^{-5} or 10^{-6} that the appeal board believes is necessary as a demonstration, and that the staff has relied upon in many other situations, and particularly, as I say, in the case of the protection system, that we -- well, I am sure that you must say that the overall reliability, including the high pressure injection system and the time to improve and fix the emergency feedwater system, that overall the reliability is adequate.

But it would take a demonstration, it seems to me. Otherwise, I don't see how you arrive at the conclusion. Possibly you can arrive at a conclusion that at the moment there is demonstrated adequate protection for the health and safety of the public.

CHAIRMAN SMITH: Mr. Dornsife, could I ask you for a better explanation of the point that you were making?

Is it your point that the fiture to be considered ha to take into account the number of main feedwater failures, too?

MR. DORNSIFE: No. I just noticed that many of the incidents that were reported were failures on using the system for startup. The system demanded for startup may be five or six times a year. So that would, instead of making the number -- say if that were the average, instead of making the failure rate one for every 25 years, you would multiply that times 6, and it would be one per every 150 demands would be the failure rate, and then if you multiply that by the number of demands, or number of times the system is required per year, then you get an overall failure rate per year.

CHAIRMAN SMITH: But my point --

MR. DORNSIFE: Which is much lower than we have been talking about, which what I think --

DR. JORDAN: That is the number the appeal board and the Commission has been relying on.

MR. DORNSIFE: I think you were using failure of main --

MR. BAXTER: And that is not what all the 25 events are.

DR. JORDAN: That's right. That's right. Okay.

All right. As I say, I am willing to go back and listen to better numbers, but what I need now is a demonstration that, a) the Appeal Board is wrong or -- and therefore that the staff witnesses this morning have -- are collect in relying entirely upon the criteria for protection, and that this in itself will be a demonstration of the adequacy of the proposed fixes or some sort of a demonstration.

Now, the licensee still promises he is going to come in with further testimony, but I think he realizes now that he has a rather tough burden. But nevertheless, you see exactly what the problem is, so I would say think it over carefully before you do come in with testimony. And I just feel that the staff that to come back.

MR. CUTCHIN: I understand your problem. You have given us some options. You are saying we have to show you it is wrong to have a numerical goal, or if there is a numerical goal, it should be something different from what the Appeal Board set out; and you are looking for some numerical comparisons it sounds like to me.

DR. JORDAN: I don't know but what -- you see, it may well be that the overall reliability of this system, taking into account all the things that are being proposed, is indeed adequate. It may well be. I have no way of knowing this at all. But we must have something on the record to show it.

MR. CUTCHIN: And you feel comfortable with numbers.

DR. JORDAN: I feel comfortable with numbers, yes.

MR. BAXTER: May I comment on the numbers and what led the Appeal Board -- it may provide background at least for how we viewed the decision.

It is my reading of that decision that the Appeal Board was only inspired to investigate the probabilities of this event, i.e., the total loss of all AC power, because of the St. Lucie plant. There was a relatively high probability of the loss of offsite power because of the peninsular geographic configuration.

And in the absence of evidence I am aware of -- and maybe that is what we have to come up with -- that the demand rate for emergency feedwater is comparable, it is not clear to me that the Appeal Board decision stands for the fact that one must always do a probabilistic analysis.

DR. JORDAN: That is right. I agree. And if it were not but for the many statements in the various Commission documents to the effect that the -- we have a special situation with respect to B&W systems and with rates of challe e, namely loss of main feedwater, with the high challenge rate it seems to me that the situation here is very similiar.

We have a challenge rate which is perhaps higher than they had at St. Lucie, and a relability figure which is lower.

MR. BAXTER: It seems to me maybe the first level of inquiry, though, is whether the preliminary conclusions reached in May 1979 by NUREG-0560 are valid. I recognize this is not testimony. It is not going to count for anything, but for whatever it is is worth, in the Rancho Seco proceeding Mr. Capra testified that subsequent investigations have shown the frequency of feedwater transients for B&W plants are between those of CE and Westinghouse plants.

MS. WEISS: Mr. Capra testified?

MR. BAXTER: Yes. They now fall in the middle. And I am not sure there when he said feedwater transients he was not speaking for the demand rate for emergency feedwater or all feedwater transients. But it is not clear to me any more that we do have a special situation with B&W plants.

DR. JORDAN: Maybe that is right. Maybe that is the answer. I don't know.

MR. CUTCHIN: I think it is clear you are not happy with the story you have heard so far, and we have to tell you a more convincing story.

DR. JORDAN: That is right.

(Board conferring.)

CHAIRMAN SMITH: We are going to take our morning break, 15 minutes.

(Brief recess.)

BY DR. JORDAN:

Q Do you have a copy of NUREG-0667?

A (WITNESS WERMIEL) Yes, I do.

Q Would you turn to page II-2 and II-3? I am going to read a few paragraphs which are entitled "Findings," and these findings will be in part the basis for my concern that B&W plants are in a somewhat special category.

The first finding of this task force reads as follows: "It was confirmation that B&W designed plants are more responsive to secondary side perturbations than other pressurized water reactors. Finding 2: The once-through steam generator design is technically sound. However, it requires a highly interactive and responsive control system, i.e., the integrated control system. Three: A high degree of overall plant interaction is inherent in the integrated control system and the once-through steam generator. Four: Based on the design features and the faster response of B&W plants during transients and upset conditions, the operators may be required to take more rapid action and have a better understanding of instrument response than operators on plants having other designs."

Now, this report was published in May of 1980. Were any of you involved in this report?

A (WITNESS WERMIEL) No, sir, I was not.

A (WITNESS LANTZ) No.

A (WITNESS JENSEN) No.

(Board conferring.)

CHAIRMAN SMITH: My concern with Dr. Jordan's questions out of 0667 are that he read four findings of which bring into question the once-through steam generator system, and my memory of the report -- I did not know he was going to ask questions on it, but my memory of the report goes on to an additional finding. And that is, because of the sensitivity, recovery is more achievable faster to which -- I cannot find it right there -- but I felt that the four items he read should be read also in company with the findings which are favorable as far as the once-through steam generator system is concerned.

Apparently the finding I was referring to, the small inventory in the once-through steam generator which created some of these problems also has a plus to it, and that is their recovery is faster and easier, too. And I think that that aspect of it should have been included at this time.

DR. JORDAN: Perhaps the staff will be able to find that for us.

CHAIRMAN SMITH: None of this, of course, is evidence. I just pointed out to him that the finding was there, and Dr. Jordan agreed that if he could find it, it should be put in at this time.

MR. POLLARD: I see there is some reference to advantages in the paragraph preceding where Dr. Jordan started reading on page II-2, but it does not say specifically what the advantages are. There is a sentence that says, "However, replacement of the once-through steam generator does not appear to be a practical or necessary action for operating plants, especially when weighed against certain other safety advantages of the OTSG."

CHAIRMAN SMITH: Let's let the observation stand. If it is in there, it is in there. I will find it in due course.

BY MR. JORDAN: (Resuming)

Q The reason I bring this up now is to ask the witnesses in view of the fact that this was written quite some time ago has there been any developments within the staff to have changed these findings?

A (WITNESS WERMIEL) None that I am aware of.

Q You do not particularly have any position different from that?

A (WITNESS WERMIEL) No.

Q All right.

MR. CUTCHIN: Dr. Jordan, it may be helpful to note -- and this is a place I will step in -- this was a task force document, and based on those findings they made certain recommendations for improvements. And as I understand it, many of the improvements that have been incorporated as staff requirements stem from or at least are identical to some of the recommendations in here. And I am not sure how many of them or whether these witnesses know all of them, but Mr. Wermiel may well be able to give that comparison. He can say whether he can or not.

DR. JORDAN: You have made the observation that I was really seeking. And I gather that it is the staff position that although not all of these recommendations have been adopted in the document which you circulated to the parties, that they have all been considered by the staff, and those that are -- upon consideration felt must be adopted have been put into the final document.

Is that stated correctly?

MR. CUTCHIN: I can only state that that is my understanding, that these recommendations have been considered, and those that have been felt necessary for short-term implementation have been somehow reflected in the staff requirements.

I think it is interesting to note as well on page II-2 that in spite of all these recommendations, the task force clearly stated right above where you started reading the general findings that even the task force itself does not believe that plant shutdown of B&W plants is even necessary or desired with regard to public health and safety until these things are fixed.

DR. JORDAN: Yes, fine.

MR. BAXTER: Mr. Smith, I think the reference you had in mind may be on page VII-7.

(Pause.)

CHAIRMAN SMITH: That is generally it. My problem was I was under the mistaken impression that Dr. Jordan had read some but not all of the findings, and my memory was incorrect that one of the findings was the rapid recoverability after a feedwater transient; and you are referring to the general subject matter, yes.

BY DR. JORDAN: (Resuming)

Q The staff who prepared this document refers in several cases to our event tree/fault tree studies. Are those the ones that you think are the B&W studies?

A (WITNESS WERMIEL) I am not sure. Do you know where they are referring to that? It is probably something more than that, Dr. Jordan.

Q Well, I was looking on page VI-3. They say "The core melt probability and public risk associated with the Crystal River plant are dominated by transient initiated accidents." That is in itself not new.

At the bottom of the page they say, "The IREP Crystal River study has tentatively concluded that transient-induced accidents are highly significant contributors to the likelihood of core meltdown in the Crystal River plant."

And presumably it means that there has been -- that the IREP study last May had progressed far enough to have made such conclusions. And so I guess I am really wondering why it is that the IREP study has not come out or has it come out? And wouldn't it be helpful under these circumstances to have the conclusions of that study?

A (WITNESS WERMIEL) I do not know if it has come out yet or not. I do know it was delayed.

Q Well, I want to go back to just a few of the recommendations starting on page II.4.

MR. CUTCHIN: Dr. Jordan.

DR. JORDAN: Yes?

MR. CUTCHIN: The Board question number 3 asks some questions about the status of IREP. I cannot give you information that is beyond that. That existed at the time the staff filed that document on 10-14. I can only refer you to that from my knowledge of the current status of

IREP. But at that time a draft report of the IREP study on Crystal River 3 had been submitted to the staff in May of '80, an three reviews were made.

The reviews identified some deficiencies in that draft report, some of which the staff believed to be significant. There was at the time of the writing of this response to the Board question some negotiations going on with the contractors to define a work scope and schedule for the revision of the draft and its publication; and it said at that time completion of the IREP study on Crystal River 3 was not expected until early calendar year 1981.

DR. JORDAN: I see.

BY DR. JORDAN: (Resuming)

Q Among the recommendations I will just point out a few. Well, first of all can you tell me for each one of these recommendations does the staff document which is supposed to index anything to anything, does it have in it the actions taken for each one of these recommendations?

MR. CUTCHIN: I was just looking for that piece of paper among those I brought to the hearing room this morning. The one that we were going to have Mr. Capra put together to come, I believe we said, December 16, yesterday, to see for myself whether 0667 was one of the documents included.

I believe it was, but I would have to confirm it by looking at the piece of paper.

DR. JORDAN: Okay. All right. I am going to ask one or two questions just to get the staff position.

BY DR. JORDAN: (Resuming)

Q It says on page II.7 "Prompt followup actions should be taken on the recommendations contained in BAW-1564." That is the integrated control system reliability analysis.

Do you know whether there have been prompt followup actions or not?

A (WITNESS WERMIEL) No, I do not.

Q Well --

A (WITNESS WERMIEL) I believe there will be a witness on that subject at a later date.

Q I do understand the staff's position that these recommendations have been considered as part of their overall recommendations, and when we get to that particular portion of the testimony I will ask him questions as to why some recommendations were not adopted. And so that is in a sense a warning, and I will not try to go into it now with these witnesses here.

MR. CUTCHIN: You are going to be, you say, asking Mr. Capra at the time he testifies why some of these were and why they were not.

DR. JORDAN: That is, presumably there are reasons why some were included and some were not, and I am going to try to get a feeling for that.

MR. CUTCHIN: Yes, sir. I will relay that.

DR. JORDAN: Okay.

(Pause.)

BY DR. JORDAN: (Resuming)

Q There is one finding that I particularly want to point out to you, not for your opinions but it bears on the things that have been said this morning; and this is on page 4 of NUREG-0560, and I will read the finding at the top of the page, or recommendation at the top of the page. These are recommendations now.

That recommendation reads as follows: "All classes of operating plants should be reanalyzed using failure mode and effects analysis to identify realistic plant interactions resulting from failures in non-safety systems, safety systems and operator actions during transients and accidents. Associated analyses should be performed for a sufficient time duration to establish that a stable plant condition had been reached, including natural circulation. Explicit consideration should be given to the effects on the loss of onsite or offsite power."

And I bring this recommendation up as one which if the staff has followed through on that recommendation, I would like to know what the progress is, and if they are not following through on that :ommen.iation, I guess then I would like to know why not. And I presume you are not in a position this morning --

A (WITNESS WERMIEL) I do not know the details of our effort in this area. I do know as part of IREP we are looking at other types of plants other than B&W plants. I do not know how extensive that program is though. I know there is --

Q You are looking at other plants?

A (WITNESS WERMIEL) Yes. There is an IREP study under way, I believe, at this time for the Calvert Cliffs Nuclear Power Plant, which is a Combustion Engineering designed facility.

DR. JORDAN: Well, I believe that covers my questions to these witnesses. I turn it back to the Chairman.

CHAIRMAN SMITH: Are there any further questions? Ms. Weiss? Mr. Pollard?

MR. CUTCHIN: None from the staff.

CHAIRMAN SMITH: You have some?

MS. WEISS: Yes.

CROSS ON BOARD EXAMINATION

BY MR. POLLARD:

Q If we could go back briefly to Standard Review Plan 10.4.9, if you look on page 10.4.9-5 near the top of the page -- I am sorry. I cannot locate mine right now to tell you. There is at the end of a paragraph a sentence which reads, "The secondary reviewers should conduct their review in accordance with the Standard Review Plan sections in their areas," or something to that effect.

Could you read it for me? I have lost mine temporarily.

A (WITNESS WERMIEL) Yes. "For those areas of review identified in subsection 1 of this SRP section as being the responsibility of other branches the acceptance criteria and their methods of application are contained in the SRP sections corresponding to those branches."

Is that what you were referring to?

Q Yes. Thank you.

And is the Instrumentation and Control System branch one of those secondary review areas?

A (WITNESS WERMIEL) Yes, it is.

Q And am I correct that in their review of the auxiliary feedwater system, instrumentation and controls that they would refer to sections 7.3 and 7.4 of the Standard Review Plan?

A (WITNESS WERMIEL) Yes, that is my understanding.

Q On page 10.4.9-2 of the Standard Review Plan, item 13 states that "The system satisfies the recommendations of Regulatory Guide 1.62 with respect to the system capability to manually initiate protective action by the auxiliary feedwater system."

Is it correct that Regulatory Guide 1.62 describes a method acceptable to the staff for complying with a requirement of IEEE standard 279?

A (WITNESS WERMIEL) I am not sure. That is not the type of a detailed review that I do myself.

(Counsel for UCS conferring.)

Q Do you know in the Instrumentation and Control branch when they review the auxiliary feedwater system instrumentation and controls, do they apply the requirements of IEEE standard 279?

A (WITNESS WERMIEL) Yes, I believe so.

Q Now, when Dr. Jordan was asking you questions I believe you stated -- and correct me if I am wrong -- that the staff does not postulate a total failure of the safety grade system in its evaluation, is that correct?

A (WITNESS WERMIEL) That is correct.

Q And is the converse true, that you do postulate the failure of a system which is not safety grade?

A (WITNESS WERMIEL) Yes, in current practice.

Q Now, as I understand from your testimony, at the time of restart the emergency feedwater system will not be fully safety grade.

A (WITNESS WERMIEL) It will be fully safety grade with respect to feedwater, transients, and small break LOCAs.

Q But it would not be fully safety grade, for example, for high energy line breaks.

A (WITNESS WERMIEL) Certain high energy line breaks.

Q And certain main steam line breaks?

A (WITNESS WERMIEL) Yes.

Q So that at least for those accidents it would be a design basis to postulate total failure of emergency feedwater.

A (WITNESS WERMIEL) Yes.

Q Am I correct, then, that for those accidents the staff is relying upon the bleed and feed mode of high pressure injection to protect or to cool the core?

A (WITNESS WERMIEL) Yes, in the interim.

Q If I could explore just a few questions with respect to the questions Dr. Jordan asked you in trying to determi ne extent of what you mean by the single failure criterion as applied in plant reviews versus reliability analyses. And I believe you stated that there are some components in the plant for which typical reviews would not postulate their failure, and I think the example you gave would be a system, for example, which had a common suction line to all the emergency feedwater pumps with a valve which was supposed to be locked open.

A (WITNESS WERMIEL) Yes, but that is not the case with TMI-1.

Q Yes, I understand that. I am just exploring the bases for your statements. Not right now on Three Mile Island Unit 1.

A (WITNESS WERMIEL) That is correct.

Q This example that you gave of a single valve which is supposed to be locked open and that you do not postulate it being in the closed position, is that because that would be termed a failure of a passive component?

A (WITNESS WERMIEL) Yes. I believe that is how we would view that particular situation. We would view it as a passive item.

Q And am I correct that the staff's meaning -- let me start over -- that the staff interprets the phrase "passive component" to be a component which does not require mechanical motion as opposed to a passive component being one that is incapable of mechanical motion?

A (WITNESS WERMIEL) The definition of "passive component" is not clear, I do not believe, in any of the NRC documentation; and I do not know how individual review areas, review branches of NRC apply the term "passive component."

Q Let's stick within your review area and sticking with this example, clearly the example you gave of a common valve suction line, that clearly is a component that is capable of being closed, is it not?

A (WITNESS WERMIEL) Yes.

Q But it is not supposed to be closed.

A That is right. It is designed to be in a fixed position at all times.

Q Okay. And then you further testified, if I recall, that although these types of failures were not normally considered in your area of review, reliability analyses have shown that perhaps they should be considered as credible failures.

A (WITNESS WERMIEL) That is correct.

Q In judging whether or not the reliability of a system is adequate would you agree that a system which is challenged more frequently would require a higher reliability to be acceptable than a system which is challenged less frequently?

A (WITNESS WERMIEL) I would not agree fully with that. I think it would depend on the nature of the challenge and the subsequent consequences of a failure of the mitigating system to function.

Q Yes, you are quite correct. Let me compare then two B&W plants and their emergency feedwater systems. Assume in B&W plant A the main feedwater system has a failure rate twice as high as the failure rate of the main feedwater system in B&W plant B. Would you agree in general, therefore, that the eme-gency feedwater system in the plant which has the higher failure rate per main feedwater would have to be somewhat more reliable than in the other plant?

A (WITNESS WERMIEL) Not really. I think I would more or less want to find out why the one particular plant had such a high challenge to its emergency feedwater system, why it was experiencing so many feedwater transients, rather than merely trying to establish that its emergency feedwater system should be better than another.

Q So there are two ways to solve the problem: either improve the reliability of the main feedwater system or improve the reliability of the emergency feedwater system.

A (WITNESS WERMIEL) Yes. I guess that's how you could look at it.

Q Thank you.

You also, as I recall, testified that to your recollection there has only been one failure of the emergency feedwater system in the entire operating life of Three Mile Island Unit 1 and 2. Is that correct?

A (WITNESS WERMIEL) No, that is not correct. It was my understanding that there was only one feedwater transient. I believe that is what I said.

Q Only one main feedwater transient.

A (WITNESS WERMIEL) Right. Of TMI-1 and TMI-2. I think that's what I said.

Q My point is on what did you base that statement? Did you do a review of the history of operation of the main feedwater systems at both Three Mile Island units?

A (WITNESS WERMIEL) No, I did not. I did at one time scan NUREG-0560 for TMI-1, and I noted a reference there to certain feedwater upsets, but none of which I could decide in my own mind were actual feedwater transients.

(Counsel for UCS conferring.)

MR. POLLARD: Ms. Weiss has a few questions.

BY MS. WEISS:

Q I am not sure with all the NUREGs that we discussed this morning that I am completely clear on what appears in each. There was a discussion of the reliability analyses done by at least three of the vendors -- CE -- done for CE plants, Westinghouse plants, and B&W plants.

Staff, if I understood your testimony, did the review for Combustion Engineering and Westinghouse. B&W did the review of B&W plants, and then the staff reviewed that. Is the review complete yet?

A (WITNESS WERMIEL) I believe the review of the B&W reliability analysis for the emergency feedwater systems is complete. As I say, I have seen a draft version, and I do not know what the status of the final report is on that.

Q But it doesn't -- the results of that review do not appear in any of the NUREGs that we discussed this morning.

A (WITNESS WERMIEL) No, they are not documented in a NUREG.

Q Okay. You mentioned that the staff concurred in the methodology, at least in the draft you saw, in the methodology used by B&W, and that it concurred with the recommendations made for improvements. Isn't that your testimony?

A (WITNESS WERMIEL) Yes.

Q Would you tell me whether or not they concurred in the results of the use of the methodology? I was just wondering whether you had chosen your words very carefully for some particular reason or was there something that you know of that they did not concur in?

A (WITNESS WERMIEL) I do not remember everything that was in the draft. What I was, I guess -- what I am really not entirely sure about is how they viewed the discrepancy identified by B&W in Appendix B. I just don't recall what they said about that.

Q Could you tell me, if you know, what the recommendations were for improvements?

A (WITNESS WERMIEL) Yes. One recommendation was to attach the interface in the control system with the ICS system, removal of the suction strainers, and I believe in the case of a total loss of offsite power and all onsite AC, a modification be made to the steam supply to prevent a potential degradation of the steam pressure or an overspeed trip of the turbine-driven pump in the event of failure full open of the control valve, the steam control valve.

Q Those were all done, to your knowledge?

A (WITNESS WERMIEL) If I can refer back, I can see if there were any others.

Q Sure.

A (WITNESS WERMIEL) Okay.

(Pause.)

A (WITNESS WERMIEL) There are others. There was a concern with potential system failures due to preventive maintenance outages affecting one pump, coupled with component failures affecting both the other pumps.

There was a concern with potential human error when testing the motor-driven pumps to leave the manual motor-driven pump discharge valve closed.

And then there was a concern with potential steam supply inadequacies as a result of stuck-open safety valves on the steam supply line and failures associated with the steam emission valves.

Q Is that all?

A (WITNESS WERMIEL) That is it.

Q Were there any recommendations associated with those last three concerns?

A (WITNESS WERMIEL) Well, they have been identified as areas that should be -- you know, something should be done about.

Q But no specific --

A (WITNESS WERMIEL) No specific statements about what to do about them.

Q With regard to the discussion about dominant failure modes and your judgment that a single failure in component is the dominant failure, you have talked some with Dr. Jordan and Mr. Pollard about the definition of single failure in the context of 10 CFR Part 50, Appendix B -- Appendix A, excuse me.

Do you have any -- how would you define a single failure in the context of reliability analysis? Just any component failure?

A (WITNESS WERMIEL) Yes, I believe that that is basically correct. I think they view any potential single component failure within the system that negates the system's capability to do its function as a single failure.

Q So really, just the common English meaning of the term would be the one that you apply in that context?

A (WITNESS WERMIEL) That is right. I think it is somewhat broader than the one we would use in our safety reviews.

Q Okay. Now, would you agree, though, that the area of greatest uncertainty with respect to the reliability analyses is the area of human error? In other words, that is the area where you really know least about how close you are to failure rates, to estimating failure rates?

A (WITNESS WERMIEL) That is my feeling, yes.

Q Do you have any idea of the range of uncertainty?

A (WITNESS WERMIEL) No, I do not.

Q Just a couple of questions about your response on the St. Lucy, that general question. With regard to your interpretation of Commission precedent, I take it to be your interpretation that the probable -- that the numerical safety goal has never been applied to any situation outside of an external hazard situation, like a plane crash or a missile or an earthquake?

A (WITNESS WERMIEL) I believe Dr. Jordan mentioned we now have applied it to ATWS.

Q ATWS? Do you know of any others?

A (WITNESS WERMIEL) No. I don't. I didn't even realize we had applied it to ATWS.

Q Well, did you write that portion of the testimony, that first paragraph, yourself, or did you consult with your attorneys?

A (WITNESS WERMIEL) No. I wrote the first paragraph. I believe you are referring to my answer to 6K?

Q Yes.

A (WITNESS WERMIEL) No, I wrote that based on a little bit of background work that I did on my own.

Q Did you include in that background what the survey of past agency precedent, past appeal board and Commission decisions, licensing board decisions --

A (WITNESS WERMIEL) No.

Q And I assume that your answer was reviewed? You know, you obviously -- your superiors and your attorneys took a look at it?

A (WITNESS WERMIEL) Oh, yes.

Q Did anybody, to your knowledge, during the course of that review, take occasion to review Commission precedent, appeal board and Commission decisions, licensing board decisions?

A (WITNESS WERMIEL) Not that I am aware of.

Q Just, I think, one more question. There has been some discussion of the failure rate historically, quite a bit, of emergency feedwater systems and the failure rate of TMI-1 and TMI-2. There is not any evidence, is there, that the emergency feedwater system for Three Mile Island Unit 1 is significantly different in the statistical sense, that its reliability is significantly different from the average plant?

A (WITNESS WERMIEL) I am not sure what you mean by "average plant." I don't know that there is an average plant. We cite such a broad range of reliability for the three cases that --.

Q Let me try it again. There is going to be, I think, quite a bit of discussion from today onward about the extent to which you can apply these historical failure rate data. Is there any reason that you know of why those data cannot be applied to Three Mile Island Unit 1 in the way in which they were applied today?

MR. BAXTER: The data in the question meaning the data for all nuclear power plants?

MS. WEISS: That is right.

WITNESS WERMIEL: The LER's?

BY MS. WEISS: (Resuming)

Q The historical failure rate.

A (WITNESS WERMIEL) I think so much of what is in an LER does not necessarily describe the significance of an inherent system design difference between a particular feedwater system in one plant and a particular feedwater system in the other.

I am not -- I believe, for example, in NUREG-0611, I think where there is discussion of feedwater transients, I believe it is pointed out that differences in plant desi n might preclude transients from occurring.

Q But then they might invite other transients that have not occurred in the other plant?

A (WITNESS WERMIEL) I don't know that to be the case. But there are certain differences in design of feedwater systems which might impose them to -- might cause them to be e susceptible to a transient than in other plants.

Q But that is -- as a theoretical statement nobody could quarrel with what you said. But in terms of trying to apply the historical failure rate, what is the significance of that?

A (WITNESS WERMIEL) If you go strictly by the historical failure rates, and I guess attempt to develop numbers from that, I suppose it is as applicable to one plant as another.

Q It would certainly be at least as reliable as trying to project a failure rate based on hypothetical fault trees and event trees, wouldn't it?

A (WITNESS WERMIEL) I don't know that there is anything hypothetical about a fault tree. What maybe is hypothetical are the numbers you attach to it.

Q Right. You are right.

A (WITNESS WERMIEL) A fault tree identifies a set fault. There is nothing hypothetical about that.

Q But you have to --

A (WITNESS WERMIEL) Certainly the data base for the numbers is questionable.

Q Well, we will be talking about that at great length later. I don't think I have any more questions of you on that subject.

Let me just check one more piece of paper.

(Pause.)

MS. WEISS: No, I have no further questions at this time.

CHAIRMAN SMITH: Mr. Adler, do you have questions?

MR. ROBERT ADLER: Yes, we have a few questions, Mr. Chairman.

BY MR. ADLER:

Q Mr. Wermiel, do you consider the emergency feedwater system to be an ECCS system within the context of 10 CFR Part 50.46 and Appendix K?

A (WITNESS WERMIEL) No, I do not.

Q Isn't the emergency feedwater system necessary to mitigate the effects of small break LOCA's?

A (WITNESS WERMIEL) I believe the discussions that it was for certain very small breaks.

Q Well, doesn't the evaluation required by 50.46 require you to take into account all systems that are required to mitigate loss of coolant accidents?

A (WITNESS WERMIEL) I am not entirely sure how we apply 50.46. In the future based on these new analyses, perhaps the emergency feedwater system would be included in the context of that. But I really do not know that to be a fact.

Q Mr. Jensen, you have testified as to the use of emergency feedwater in the mitigation of small break LOCA's. Do you agree with Mr. Wermiel's testimony?

A (WITNESS JENSEN) I agree with him. I don't believe it is considered to be an emergency core cooling system at this time. It is a system that helps to mitigate the effects of the small break LOCA. I am trying to think of another example of a system which would do that, and that would be the scramming of the safety rods. They would also mitigate small break LOCA, and I don't believe they are considered to be an ECCS system.

CHAIRMAN SMITH: Do you take credit for emergency feedwater system in 50.46 analysis?

WITNESS JENSEN: The analyses that were done after the TMI-2 event showed that emergency feedwater would be required if only one high pressure injection train were available, to ensure that the core damage limits of 10 CFR 50.46 were obtained.

MR. DORNSIFE: I have one follow-up to that.

BY MR. DORNSIFE:

Q It would be correct to say that the reason emergency feedwater is not considered to be an ECCS system at this time is the fact that none of the analysis for acceptance of the ECCS acceptance criteria has ever assumed a break that needed to use emergency feedwater; is that correct? And that maybe if some are done in the future, then emergency feedwater might be considered an ECCS system?

A (WITNESS JENSEN) I just don't know the definition that would be applied. Perhaps ECCS may just apply to systems that provide water to the reactor core itself, rather than other systems that would help to mitigate the -- to mitigate a loss of coolant accident.

Q I have a couple of other questions for Mr. Wermiel. In your answers to Mr. Pollard's questions concerning passive failures and valve misalignments, I think you cited the example of the suction valve being closed by lack of administrative control, and that you would consider that to be -- the staff would consider that to be a passive failure; is that correct?

A (WITNESS WERMIEL) In the current context of our reviews, yes.

Q How would you consider, then, an operator in performing a procedure, a procedural step in an emergency step, taking an improper action and changing the position of the valve incorrectly? How would that be viewed?

A (WITNESS WERMIEL) When we do our safety reviews, we have not in the past accounted for an operator error in determining the acceptability of the system design.

Q I understand that. But how would you view that? In your opinion, what would that be? Would that be an active or a passive failure?

A (WITNESS WERMIEL) I think it would -- are you talking about a valve that is supposed to be in a normally open position?

Q There are some emergency procedure follow-up actions that require the operator to change the position of valves, is that true?

A (WITNESS WERMIEL) To do surveillance testing, yes.

Q Not for actually performing emergency procedures?

A (WITNESS WERMIEL) Performing an emergency procedure?

Q Yes.

A (WITNESS WERMIEL) Yes. I guess in certain circumstances an operator is called upon to perform a realignment of valves.

Q So what if he just makes a mistake and does not align it properly? Is that an active or passive failure?

A (WITNESS WERMIEL) I would view it as a passive failure. I would consider an active failure a failure of a motive component to move or to function as it was supposed to.

Q In your opinion, which would be the more probable, an operator not taking proper action for an emergency procedure or a violation of administrative procedures as far as the first case, where you have someone checking the line-up and a system of locks and administrative controls? Which in your opinion is the most likely?

A (WITNESS WERMIEL) Again, I am not real familiar with operator errors and what is called for in procedures. But I would say it is probably more likely that an administrative procedure might be violated.

Q Even if it is done and then checked and locked administratively, than someone performing an emergency procedure in the heat of an emergency?

A (WITNESS WERMIEL) I think maybe Mr. Lantz can bear me out better. But I would think that LER's tend to show normal routine practice within the plant shows up as a more common occurrence than mistakes taken under accident situations, I think. I believe that to be the case.

I will tell you the reason I say that is because I think you would be required to do your normal routine administrative chore more often than you would be in a highly stressful situation. Therefore, I think you would, just by the amount of time involved in that condition, that you tend to violate a more routine thing more often.

Q The new requirement for a manual independent check of the lineup, would you think that that would have a greater rate as far as one operator making an action?

A (WITNESS WERMIEL) I have not done a check of the probability of such a thing occurring. I don't know. We don't have LER data now on these new practices, I do not think.

Q One more brief question. I think you said that it is difficult to tell, in answer to Ms. Weiss' question, from historical data it is difficult to tell whether TMI is typical or atypical from the experience. It seems from my reading of the LER's that were cited in the testimony that probably anywhere from half to three-quarters of the systems that suffer failures appear to be systems where there are two turbine-driven feedwater pumps and not systems where you have diverse power sources. Is that correct?

A (WITNESS WERMIEL) Yes. I think inherently a motor-driven pump is more reliable than a turbine-driven pump.

Q Is it more the diversity of the power sources that is more reliable?

A (WITNESS WERMIEL) Yes. Diversity would help to improve the reliability of the system.

Q So wouldn't you say that the historical data tends to indicate that maybe the TMI system is more reliable than the average?

A (WITNESS WERMIEL) Yes.

MR. DORSIFE: thank you.

CHAIRMAN SMITH: Anything further for these witnesses?

BY MR. CUTCHIN:

Q In the discussion a few minutes ago there was concern about whether or no the emergency feedwater system was an emergency core cooling system. Would it make any difference in the design requirements imposed upon the emergency feedwater system as an accident mitigating system whether it be called an ECCS system or just an emergency safety feature?

A (WITNESS WERMIEL) No, it would not. We are now requiring that the system be a safety grade system. Its categorization I do not think is that significant.

MR. CUTCHIN: Thank you. No further questions.

CHAIRMAN SMITH: The question was in the other direction, however, wasn't it?

MR. CUTCHIN: The question was, as I understood it, Mr. Chairman, is this an ECCS system.

CHAIRMAN SMITH: Okay.

MR. CUTCHIN: In terms of what quality goes into the design of the system. I was trying to bring out whether it makes any difference that it be called one thing or the other. It is the function that it must perform that is important.

MR. ROBERT ADLER: Mr. Cutchin interpreted my question correctly.

CHAIRMAN SMITH: Okay.

Anything further?

MR. CUTCHIN: Nothing from the staff.

CHAIRMAN SMITH: You are excused, gentlemen.

(Witnesses excused.)

MR. BAXTER: I have one matter before lunch, Mr. Chairman. Recently Ms. Weiss filed and transmitted to the Board and the parties copies of IEEE Standard 279, 1968 version, and IEEE 603, the 1977 trial use standard.

I would like the record to show I am going to distribute now a copy of IEEE Standard 279, 1971 version. And I would also like to have a short bench conference with the Board and parties before we leave the room.

CHAIRMAN SMITH: Okay. Do you want this off the record?

MR. BAXTER: Yes.

CHAIRMAN SMITH: Okay.

(Bench conference.)

(Whereupon, at 11:58 a.m., the hearing was recessed, to reconvene the same day.)

AFTERNOON SESSION

(1:05 p.m.)

MR. BAXTER: Mr. Chairman, if you don't have it with you, I would advise the Board it would be handy to have a copy of Mr. Pollard's testimony on UCS Contention 10.

Whereupon,

ELMER S. PATTERSON

PHILIP R. CLARK

MICHAEL J. ROSS,

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

DIRECT EXAMINATION

BY MR. BAXTER:

Q Gentlemen, I call your attention to a document which bears the caption of this proceeding. It is dated September 15, 1980. It is entitled "Licensee's Testimony of Philip R. Clark, Michael J. Ross, and E.S. Patterson in Response to UCS Contention No. 10 and Sholly Contention No. 3 (Safety System Bypass and Override."

Before I go further with that, though, let me ask each of you from left to right to give for the record your name and your business affiliation and title.

A (WITNESS PATTERSON) I am Elmer S. Patterson. I work for Babcock & Wilcox, and my title is advisory engineer. I operate as a technical advisor to the engineering section in B&W Lynchburg.

A (WITNESS CLARK) I am Philip R. Clark. I am vice president - nuclear activities at GPU Service Corporation.

A (WITNESS ROSS) My name is Michael J. Ross. I am employed by Metropolitan Edison. My position is supervisor, unit operations, TMI Unit 1.

Q Is the testimony associated with your name and the document I previously identified, including the attached statement of professional qualifications, testimony which you have prepared or had prepared under your direct supervision for presentation at this hearing?

Mr. Patterson?

A (WITNESS PATTERSON) Yes, it has.

Q Mr. Clark?

A (WITNESS CLARK) Yes.

Q Mr. Ross?

A (WITNESS ROSS) Yes, it is.

Q Mr. Patterson, do you have any changes or corrections to your testimony?

A (WITNESS PATTERSON) No, I do not.

Q Mr. Clark, do you have any changes or corrections to your testimony?

A (WITNESS CLARK) Yes. I would like to, on page 6

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CHAIRMAN SMITH: Mr. Ross, do you have in your possession a copy of the direct testimony that is going to be --

MR. BAXTER: Excuse me, Mr. Chairman. I already had Mr. Clark make the noted change before I gave it to the reporter.

CHAIRMAN SMITH: Thank you.

WITNESS CLARK: Page 6, seventh line up. In order to clarify it, we should insert the word "high" before the word "pressurizer."

CHAIRMAN SMITH: So it would be --

WITNESS CLARK: That line would read: "Primary system is subcooled and a high pressurizer water level is indicated."

BY MR. BAXTER: (Resuming)

Q Does that complete your changes?

A (WITNESS CLARK) Yes.

Q Mr. Ross, do you have any changes to your testimony?

A (WITNESS ROSS) I do not.

Q Mr. Patterson, is your testimony true to the best of your knowledge and belief?

A (WITNESS PATTERSON) Yes, it is.

Q Mr. Clark, as amended is your testimony true and accurate to the best of your knowledge and belief?

A (WITNESS CLARK) Yes.

Q Mr. Ross, the same question.

A (WITNESS ROSS) Yes, it is.

MR. BAXTER: Mr. Chairman, I move the receipt into evidence of the testimony and ask that it be physically incorporated into the transcript as if read.

MS. WEISS: No objection.

CHAIRMAN SMITH: It is so received.

(The document referred to follows:)

11/20

LIC 9/15/80

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

LICENSEE'S TESTIMONY OF PHILIP R. CLARK, MICHAEL J. ROSS AND E. S. PATTERSON IN RESPONSE TO UCS CONTENTION NO. 10 AND SHOLLY CONTENTION NO. 3 (SAFETY SYSTEM BYPASS AND OVERRIDE)

OUTLINE

The purposes and objectives of this testimony are to respond to UCS Contention 10 and Sholly Contention 3, which assert that operator ability to intervene in a safety function following automatic initiation violates standard IEEE 279 as incorporated by NRC regulations and endangers public health and safety. The testimony shows that operator intervention in a safety function, following initiation of a protective system action, does not violate applicable criteria. Further, the testimony describes why such operator intervention is desirable and may be necessary in certain circumstances.

INDEX

INTRODUCTION

This testimony, by Mr. Philip R. Clark, Vice President, Nuclear Activities, GPU; Mr. Michael J. Ross, TMI-1 Supervisor of Operations, GPU; and Mr. E. S. Patterson, Technical Advisor to Equipment Engineering Section, Nuclear Power Generation Division of Babcock & Wilcox Company, is addressed to the following contentions:

UCS CONTENTION NO. 10

> The design of the safety systems at TMI is such that the operator can prevent the completion of a safety function which is initiated automatically; to wit: the operator can (and did) shut off the emergency core cooling system prematurely. This violates §4.16 of IEEE 279 as incorporated in 10 CFR 50.55(a)(h) which states:
>
> > The protection system shall be so designed that, once initiated, a protection system action shall go to completion.
>
> The design must be modified so that no operator action can prevent the completion of a safety function once initiated.

SHOLLY CONTENTION NO. 3

> It is contended that as a result of Licensee's Operating Procedures, the emergency core cooling system can be defeated by operator actions during the course of a transient and/or accident at Unit 1, such defeat consisting of either throttling back the high-pressure injection pumps or tripping these pumps. It is further contended that under the conditions of a loss-of-feedwater transient/loss of coolant accident at Unit 1, defeat of the emergency core cooling system high-pressure injection system by pump throttling and/or pump trip results in significant

cladding metal-water reaction, causing the production of amounts of hydrogen gas in excess of the amounts required by NRC regulations to be considered in the design and accident analysis of nuclear power plants. It is contended further that such production of hydrogen gas results in the high risk of breach of containment integrity due to the explosive combustion of the hydrogen gas in the containment. Inasmuch as the emergency core cooling system is an engineered safety feature which is relied upon to protect the public health and safety, and because proper operation of the emergency core cooling system is required to provide reasonable assurance that Unit 1 can be operated without endangering the public health and safety, it is contended that the emergency core cooling system operating procedures must be modified in order to ensure compliance with the GDC 35 requirement of negligible clad metal-water reaction following a loss-of-coolant accident (LOCA). It is further contended that the emergency core cooling system operating procedures must be appropriately modified prior to restart in order to provide for protection of the public health and safety.

RESPONSE TO CONTENTIONS

BY WITNESS PATTERSON:

UCS Contention 10 asserts that operator ability to intervene in a safety function following automatic initiation violates NRC regulations and that system design must be changed to prevent such operator action. The UCS interpretation of the cited requirement - Section 4.16 of IEEE 279, as incorporated in 10 CFR Part 50, Section 50.55a(h) - is not valid.

BY WITNESSES CLARK AND ROSS:

Contrary to the thrust of these contentions, the ability for the operator to control a safety function following initiation serves to enhance safety.

BY WITNESS PATTERSON:

Section 1 of IEEE 279-1968, from which the above portion of Section 4.16 is extracted, defines the scope of the protection systems addressed by that standard as follows:

> For purposes of these Criteria, the nuclear power plant protection system encompasses all electric and mechanical devices and circuitry (from sensors to actuation device input terminals) involved in generating those signals associated with the protective function. These signals include those that actuate reactor trip and that, in the event of a serious reactor accident, actuate engineered safeguards such as containment isolation, core spray, safety injection, pressure reduction, and air cleaning.

The requirement of Section 4.16 of IEEE 279 as cited by UCS is therefore applicable only in the context of this protection system scope. For example, for a condition requiring the Emergency Core Cooling System (ECCS), the protection system shall be so designed that, once initiated, nothing within the protection system can prevent the signal from completing its specified action, which is actuation of the ECCS.

In support of this position it should be noted that the 1971 issue of IEEE 279 clarified the portion of Section 4.16 cited by UCS to read:

> The protection system shall be so designed that, once initiated, a protective action <u>at the system level</u> shall go to completion. (Emphasis added.)

Except for the term "plant" (1968) versus "generating station" (1971) both versions of IEEE 279 define "system" as follows:

> Where not otherwise qualified, the word "system" refers to the nuclear power plant protection system, as defined in the scope section of the criteria.

The definition of the protection system given in the scope, Section 1, of the standard as quoted above remained essentially unchanged from the 1968 to the 1971 versions.

Clearly, the contended application of IEEE-279 is without a factual basis. The standard is directed at initiation of a protective action, and not at completion of the subsequent safety function.

<u>BY WITNESS CLARK</u>:

Licensee absolutely disagrees with the basic philosophy underlying this contention. The contention implies that it is necessary to provide automatic circuitry to prevent the operator from modifying any protective action once it has been initiated. Not only is this impractical, but attempts to carry out this philosophy would seriously complicate the plant and detract from safety. Contrary to this philosophy, the real need is to prepare the operators to correctly diagnose the plant condition and carry out the appropriate actions.

From the very beginning of the nuclear power industry, the plant operator has been recognized as a required element in correct plant operation. This parallels the philosophy in other industries, such as transportation, where the operator is also highly important. It has always been recognized that it would be impossible to construct a plant which would operate correctly under all conditions, and that a properly trained operator in control of the plant is the best continuing guarantee of correct operation. This is particularly true since it is impossible to foresee every possible condition which could arise. The operator, when properly prepared for his task, is infinitely more flexible in responding to unexpected situations than any possible automatic control mechanisms.

The principal criteria for selecting actions assigned to the operators is that they must be actions operators can reasonably be expected to perform and for which they can be adequately trained. Very rapid actions required for immediate response to sudden unanticipated changes in plant conditions, for example, do not meet these criteria. For this reason the immediate actions of protective systems (e.g., reactor trip, ECCS actuation and containment isolation) are automated and the operator action is simply to verify that the automatic circuitry has functioned properly. Subsequent bypass of such circuits, on the other hand, proceeds on a much more deliberate basis. The operators have ample opportunity to verify that the conditions prerequisite to bypass are in fact met. They can, as appropriate, refer to written operating procedures and/or consult with their immediate supervisor prior to activating the bypass. It is fully appropriate, therefore, that this type of action remains under operator control.

It should be noted that continued addition of automatic circuits does not insure greater safety. Additional complexities may in fact be counter-productive to safety. The goal must be to keep the plant sufficiently simple that plant operators can understand the plant design, its current configuration, and the appropriate operator actions. Additional complexities should be added only where the operator really requires them to perform his job.

Deliberate operator intervention is desirable and necessary after appropriate conditions exist in an accident sequence, as illustrated by the following examples. (1) Following a small-break loss of coolant accident, if the primary system is subcooled and a high pressurizer water level is indicated, the operator may throttle ECCS flow. In this manner the operator can properly continue the required safety function, i.e., assuring adequate core cooling, while placing the plant into a preferred shutdown condition. Without this action, large quantities of water containing some amount of radioactivity would be released to the reactor containment building, requiring cleanup actions and some degree of personnel exposure. (2) It may also be necessary for the operator to open containment isolation valves after their automatic closure to take samples of the primary coolant or containment atmosphere in order to assess post-accident conditions. This may be desirable or necessary to determine the appropriate actions related to continued containment and cleanup of radioactive products. (3) Operator intervention is desirable to prevent the Emergency Feedwater System from feeding a damaged steam generator following a steam line break in the intermediate building. Stopping the steam flow from the break serves to reduce the hazard to personnel who may be located near the break. (4) It may also be necessary to secure emergency feedwater to prevent overfilling a steam generator if a control valve malfunctions. This minimizes the possibility of generating a water hammer in the main steam lines, with possible damage to equipment. (5) Under all conditions following inadvertant actuation, the ability to bypass the protective action promptly is desirable to avoid unnecessary plant transients or to protect personnel.

BY WITNESS ROSS:

As pointed out in NUREG-0578 and in Sholly Contention No. 3, the concern is not with the capability for the operator intervention, but rather with providing the operator with the correct information and procedural guidance on which to take subsequent actions. Additional instrumentation added to TMI-1 to provide the operator better information on the primary system conditions is discussed in Licensee's testimony on Detection of Inadequate Core Cooling. In addition, the operators have been provided with specific instructions as to when it is necessary or allowable to intervene and over-ride the automatic operation of the ECCS systems. The procedure covering loss of reactor coolant/loss of reactor coolant pressure contains the following guidance:

> CAUTION: Do not throttle HPI unless one of the following three conditions exists:
>
> a. The LPI system is in operation and flowing at a rate in excess of 1000 gpm in each line and the situation has been stable for 20 minutes.
>
> b. All hot and cold leg temperatures are at least 50°F below the saturation temperature for the existing RCS pressure, and the action is necessary to prevent the indicated pressuizer level from going off-scale high. If 50°F subcooling cannot be maintained, full HPI shall be reactivated.
>
> c. Or, all indicated hot and cold leg temperatures are at least 50°F below the saturation temperature for the indicated RCS pressure and continued full HPI injection will result in RCS pressure/downcomer temperatures within the Restricted Region of Figure 2 [which presents the allowable pressure-temperature relationship for avoidance of brittle fracture of the reactor vessel].

In short, the TMI-1 emergency procedure governing ECCS operation has been modified as recommended in Sholly Contention No. 3.

Similarly, the following guidance is given for the Containment Isolation System:

- Containment isolation valves may be opened to obtain samples in accordance with approved procedures. The isolation valves shall be reclosed after the sample is obtained.
- Other containment isolation valves automatically closed shall remain closed until the following conditions are met:
  a. Reactor building pressure is less that 2 psig.
  b. Containment radiation levels have been assessed based on radiation monitor readings or samples.
  c. The integrity of the system outside the reactor building has been assessed. (Stable surge tank level, visual inspection or pressure test should be considered to verify integrity).
  d. The Shift Supervisor or Emergency Director shall give permission to reopen containment isolation valves.
  e. Installed radiation monitors or portable monitors shall be available to detect any

release that may result from opening the valve.

In its final specification of this contention UCS included the emergency feedwater system along with emergency core coolant system and containment isolation system. As with the ECCS and containment isolation system, guidance is provided for operating the emergency feedwater system in the event a transition to natural circulation is required:

- o Take hand (manual) control of startup feedwater regulatory valves and slowly increase steam generator level to 50% on the operating range level indicator.
- o Start the motor driven emergency feedwater pumps, and establish control of the steam generator level by taking hand control and opening the emergency feedwater regulating valves.

It should be noted that if emergency feedwater has automatically started due to loss of main feedwater, the steps for manual raising of steam generator level with the emergency feedwater regulating valves are still applicable.

I have previously described in Licensee's testimony on the Detection of Inadequate Core Cooling, some aspects of operator training at TMI-1. The training emphasizes the importance of following procedures. The training and testing of operators, however, also provides assurance that operators are cognizant of procedural requirements without aid of the procedures. These personnel are required to demonstrate during testing that the immediate action requirements of emergency procedures are known. Subsequent portions of emergency procedures that require signoff by operators contain requirements for re-verification of immediate action steps.

During the Operator Accelerated Retraining Program training, the importance of consultation and communication between individuals on shift has been stressed for significant operations, such as the manual actions of reducing ECCS flow, overriding containment isolation on specific lines and manipulating steam generator secondary level.

BY WITNESS PATTERSON:

In summary, the interpretation of IEEE-279 contended by UCS is not valid. Following initiation of a protection system action, subsequent operator intervention in the safety function does not violate applicable criteria.

BY WITNESSES CLARK AND ROSS:

Further, operator intervention in a safety system operation is desirable and may be necessary in certain circumstances. Appropriate instrumentation, procedural guidance and training have been provided to TMI-1 operators on the situations in which they should intervene in the automatic operation of the ECCS, containment isolation and emergency feedwater system.

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Experience: Vice President, Nuclear Activities, GPU Service Corporation, January 1980 to present. Responsibilities include: Directing and monitoring of the operation, maintenance and testing of TMI-1, TMI-2 and Oyster Creek; directing and monitoring of support activities for these plants including design, manufacturing, quality control, training, and radiological and environmental controls; representing the GPU Nuclear Group by way of contacts, negotiations and discussions with vendors, contractors, governmental agencies, other utilities, industry organizations and citizens groups; establishing policies and procedures relating to the GPU nuclear plants; reviewing and approving staffing and budget proposals.

Associate Director, Reactors, Naval Reactors Division, U.S. Department of Energy and Chief, Reactor Engineering Division, Nuclear Power Directorate, Naval Sea Systems Command, Department of the Navy, 1964 to 1979. Responsible for the direction of a major element of the U.S. Naval Nuclear Propulsion Program. Retired U.S. Government August 1979.

U.S. Navy, 1954 to 1964. Held various positions within the Navy Nuclear Power Program.

Naval Architect, New York Naval Shipyard, 1951 to 1953.

Honors:

Navy Distinguished Civilian Service Award, 1972.

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Education: U.S. Navy Nuclear Power School, 1961. U.S. Navy Nuclear Power Prototype School, 1961.

Experience: Supervisor of Operations, Three Mile Island Unit 1, Metropolitan Edison Company, 1978 to present. Responsible for directing the day-to-day operation of the plant to ensure compliance with the conditions of the plant operating license and technical specifications, including supervision of the Radioactive Waste Processing and Shipment Group and coordination of operations and related maintenance activities with the Superintendent of Maintenance.

Shift Supervisor, Three Mile Island Unit 1, Metropolitan Edison Company, 1972 to 1978. Responsible for the management of all operations and maintenance activities, including the manipulation of any controls, equipment or components in physical plant systems on his shift.

Shift Foreman, Three Mile Island Unit 1, Metropolitan Edison Company, 1970 to 1972. Responsible for performance of various pre-operational activities, including preparation of procedures and start-up equipment checks.

Reactor Plant Technician, Saxton Nuclear Experimental Corporation, 1968 to 1970. Held position of reactor operator; additionally, was responsible for training operations staff.

U.S. Navy, 1960 to 1968. Positions held include reactcr operator aboard USS Haddo, Instructor at the Nuclear Power Training Unit, and AEC Field Representative at the Nuclear Power Training Unit

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Education:	B.A., Physics, University of Nebraska at Omaha, 1956.
Experience:	Technical Advisor, Babcock & Wilcox Company Nuclear Power Generation Division, 1973 to present. Advises Equipment Engineering Section on instrumentation matters. Instrumentation and Control Design Engineer, Babcock and Wilcox Company, 1957 to 1973. From 1957 to 1966, responsibilities included the design of nuclear instrumentation and safety systems for various nuclear ships, including the N.S. Savannah and the Otto Hahn, design and procurement of instrumentation and control systems for five test reactors and for the Babcock & Wilcox CNSG. From 1966 through 1969, was responsible for the design of Oconee-type plant reactor protection systems. From 1970 to 1973, performed various assignments relating to the design and procurement of instrumentation and control systems for the B&W NSSS. Project Engineer, Materials Test Reactor, Idaho, 1956 to 1957.
Professional Affiliations:	Member ILEE Nuclear Science Group Standards Committee during the preparation and of IEEE 279-1968. Member Joint Committee on Nuclear Power Standards of the IEEE Group on Nuclear Science and the IEEE Power Engineering Society during the preparation and approval of IEEE 279-1971.

Joined the IEEE Nuclear Standard writing effort in 1967 as the founding Chairman of what is now the Subcommittee on Reliability under the Nuclear Power Engineering Committee. Presently the Chairman of the Editorial Subcommittee and member of the Nuclear Power Engineering Committee.

Member, U.S. Delegation to the International Electrotechnical Commission Committee on Nuclear Instrumentation, 1970-1979.

Chaired 1976 IAEA session on Software for Protection Systems, meeting on the Use of Computers for Protection Systems and Automatic Control.

Chaired 1979 IAEA session on Man-Machine Communication, meeting on Procedures and Systems for Assisting an Operator during Normal and Anamolous Nuclear Power Plant Operation Situations.

Registered Professional Engineer, California.

<u>Publications</u>:

"A Typical Incore Monitoring System," IAEA, Ontario, May 1974.

"The Need for Criteria and Philosophical Development for Human Factors Accountability in Nuclear Power Plants," IAEA, Munich, December 1979.

MR. BAXTER: Mr. Chairman, there have been previous discussions among the counsel for Licensee, Union of Concerned Scientists, and the NRC staff about the presentation immediately following direct examination, but before cross-examination, of some limited oral rebuttal testimony by witnesses.

It is my understanding that this agreement among these three parties, at least, would limit the oral rebuttal to the prefiled written direct testimony of the other parties, and that it would be so reasonably contained that parties could respond to it or could be expected to respond to it by cross-examination. By that I mean not unduly lengthy. And it would not raise surprise reports, studies, data, that the other side could not have anticipated and could not have responded to soon thereafter.

I put that understanding on the record because I plan to ask several rebuttal questions of these witnesses before cross-examination, and to make sure that we have a common understanding among the three of us.

MS. WEISS: Yes, that is correct.

MR. CUTCHIN: That is correct, Mr. Chairman.

CHAIRMAN SMITH: Okay. What would have been helpful, I believe, is if we had been forewarned as to the direct testimony concerning which rebuttal is addressed to, so we might have some questions on it too.

MR. BAXTER: It will be in all cases the direct testimony of the other party on the same contention.

CHAIRMAN SMITH: I understand that. Okay. Well, go ahead.

MR. BAXTER: So in this case it is Mr. Pollard's testimony on UCS Contention 10.

BY MR. BAXTER: (Resuming)

Q Mr. Patterson, at page 5 of his direct testimony, Mr. Pollard asserts that Met Ed and the staff argue that sealing in the electrical signal used to initiate operation of the emergency core cooling system is all that is required by IEEE Standard 279. Later in that paragraph he asserts that the staff and Met Ed arguments amount to saying that the Commission has imposed a requirement that has no purpose.

Do you agree with this observation by Mr. Pollard, and if not what is the purpose of the requirement in Section 4.16 of IEEE Standard 279?

A (WITNESS PATTERSON) I do not agree with Mr. Pollard's contention on this subject.

MS. WEISS: I cannot hear you at all.

WITNESS PATTERSON: Is that all right?

MS. WEISS: Not really.

WITNESS PATTERSON: Maybe I can speak a little louder this way. Does that help?

MS. WEISS: I think into the microphone and slowly.

CHAIRMAN SMITH: These microphones are very sensitive to distance. You have to keep the microphone very close to your mouth.

DR. JORDAN: It will help to speak slowly.

WITNESS PATTERSON: I do not agree with Mr. Pollard. The purpose of the paragraph Section 416 was basically to require that protection systems, after they trip, reset, and could not be capable of going back to an unset state of their own accord. It was to force the operator to have to take some action on his part. Some action on his part would then be required to reset the system.

The reason for this was that past history showed that things could happen in protection systems which could cause trips, and then the situation suddenly clears, and the operator would be left with a plant in an undefined state and he would not know why.

So the requirement was that if you ever have a trip, then the operator would have positive indication of what happened to him and why the plant ended up in the state that he found it in. The basic purpose, then, was to force the designer to in some manner incorporate a latching or reset mechanism in a protection system.

BY MR. BAXTER: (Resuming)

Q At pages 6 through 8 of his testimony, Mr. Pollard asserts that the choice of words used in the standard was heavily influenced by the experience with reactor shutdown systems, rather than with engineered safety features like emergency core cooling.

Mr. Patterson, your statement of qualifications indicates that you were involved in the preparation of both the 1968 and the 1971 editions of IEEE Standard 279. Do you agree with Mr. Pollard's description of the experience which influenced the selection of the language in the standard?

A (WITNESS PATTERSON) No, I do not agree with Mr. Pollard's opinion of the experience of the authors. The people that were involved in the writing of this document had experience in the -- in reactors built prior to that time.

But it was quite common in the large test reactors, typically for instance the materials test reactor, to incorporated engineered safety features such that emergency power systems, emergency cooling systems -- MTR had one that was very extensive, and we were familiar with those systems and knew something about them.

Furthermore, if you will look at the scope of the document, it says it specifically applies to emergency safety features, engineered safety features, in the 1968 version. But the same words appear in the 1971 document, and no revisions in the 1971 document were incorporated, indicating that there was anything wrong in the '68 version.

In other words, what we did in '68 was very viable in light of new experience with the systems that we had by 1971.

Q What led to the selection of the language in IEEE 279 which is quoted in the contention, "Once initiated, a protection system action shall go to completion."

A (WITNESS PATTERSON) The authoring committee was quite sensitive to trying to attempt to write down principles in such a way that it would not force designers into doing specific mechanical things in their designs.

The original thought and consideration was given to using the words that, "The system shall seal in or lock in or something of that sort." But it was considered that this might be interpreted as forcing the designer to use specific mechanical techniques, and that the better choice of words would be those that are now used in the document, therefore giving the designer a wider range of freedom in accomplishing the intent of the criteria.

Q Mr. Patterson, are you aware of any safety system which is designed to go to the completion of the protective function without the opportunity for operator intervention

A (WITNESS PATTERSON) No, I am not. Even reactor protection systems do not go to the completion of the protective function, in the sense that the reactor protection system will release and drop or scram rods. But once the rods are in, depending upon what the initiating event was, there is nothing that prevents an operator from turning around and immediately pulling the rods back out of the core.

So that this brings up one of the fundamental problems of trying to define what constitutes completion, because completion, at least in many cases, is highly dependent upon what the initiating event was -- is.

Q At page 9 of his testimony, Mr. Pollard stated that the intent of developing IEEE Standard 603 was to replace IEEE Standard 279 after two years of trial use. That is in March 1979.

Did that happen, and what is the status of Standard 603?

A (WITNESS PATTERSON) At the time Mr. Pollard was associated with the authoring committee, the intention was to replace IEEE 279 with the 603 document. However, the 603 document was somewhat defective, and that was one of the reasons it went for trial use.

Since that time, the committee has viewed the subject in a different light and it has reaffirmed IEEE 279 for another four years. It has revised and reissued IEEE

603, in which the 279 is now a supporting document, no evidence of an intention to replace 279. And 603 is now out as an approved full standard. It will be, hopefully, in print some time by the end of this month.

Q To your knowledge, has the NRC adopted IEEE Standard 603 as a requirement?

A (WITNESS PATTERSON) To my knowledge, NRC has not made any -- NRC has not adopted IEEE 603 as a document, nor has it said anything about its opinion on the future use of that document.

Q UCS Contention 10 states in part that the design of the safety systems at TMI is such that the operator can prevent the completion of a safety function which is initiated automatically, and that the design must be modified so that no operator action can prevent the completion of a safety function once initiated.

At page 2 and at pages 9 through 12 of his testimony, Mr. Pollard cites standards applicable to operating bypasses.

Mr. Ross, I would like you to explain briefly what an operating bypass is, and my question then to anyone else on the panel is whether the cited standards have any applicability or relevance to the issue raised in the contention?

A (WITNESS ROSS) In my opinion, an operating bypass is a bypass that the operator would intentionally install in a normal transition from one plant condition to another.

A (WITNESS CLARK) I do not believe the operating bypass requirements have any applicability to the contention, in the sense of whether operator intervention should be allowed after a trip or an emergency has arisen. The operating bypass is placed into effect before a trip occurs. It is placed into effect with the plant in a stable, known condition. And it is required to provide protective system function for whatever event may thereafter arise.

In distinction to that, where we are proposing operator intervention after an event has occurred, the event is known and the operator has available to him information on exactly what situation exists. He is not dealing with a wide variety of possible future events.

Therefore, the fact that the operating bypass is required to be automatically reset or locked out has no relevance to the entirely different situation which exists after a trip has occurred, when the operator has information on which to base a decision on whether or not to intervene.

DR. JORDAN: Mr. Ross, I guess I did not -- I am sure I did not understand what an operating bypass is. Would you inform me?

WITNESS ROSS: Yes. There are certain devices in the plant that, due to a normal transition from a startup mode to a shutdown mode or to a cooldown mode, that you must physically bypass the engineered safeguards system to keep it inadvertently from actuating. That in my opinion is an operating bypass.

DR. JORDAN: I see. All right.

WITNESS CLARK: Could I perhaps add to that an example of an operating bypass?

DR. JORDAN: Please.

WITNESS CLARK: Where the reactor trip would be bypassed, I guess it is below 1800 psi reactor coolant system pressure. The purpose of that bypass is to allow you to withdraw control rods with the reactor coolant system below the 1800 pounds or whatever. I forget the set point.

DR. JORDAN: I see. It would not include taking one channel out of operation in order to test?

WITNESS CLARK: I believe that that is referred to normally as a maintenance bypass, in distinction to an operating bypass.

DR. JORDAN: Thank you.

BY MR. BAXTER: (Resuming)

Q Beginning at page 16 of his testimony, Mr. Pollard asserts that the position of Met Ed and the staff is unsupportable, in that it fails to take into consideration the lessons to be learned from the TMI-2 accident. I would also note as an aside a comment of Dr. Jordan yesterday morning, perhaps indicating a preference for using automated equipment, rather than relying upon operator action, the main divergence raised by Mr. Pollard.

Mr. Clark, do you agree? d if not, why do you choose to place reliance on operator action in place of an automatic interlock?

A (WITNESS CLARK) I think perhaps first it would be useful to discuss the basic reasoning which underlies the preference for operator action as opposed to automatic initiation, and this is an important underlying principle not only in reactor design, but in related transportation and other portions of the Navy experience and other commercial endeavors as well. And it goes like this.

In a complex plant such as a commercial reactor plant, it is not practical to foresee all possible combinations of events or sequences of events which might occur. There are to be considered all of the various systems, all the various failures which might occur in each of those systems or components, all the various sequences in which those failures might occur. And it should include consideration of not only those which are, quote, "allowed," unquote, by the design basis and the safety analyses, but also others which might occur, although considered impossible or not explicitly considered in the design basis.

Since it is not possible to foresee all possible sequences of events, it is necessary ultimately to rely upon the operator.

MS. WEISS: Mr. Chairman, may we approach the bench?

CHAIRMAN SMITH: I beg your pardon? You are asking for a bench conference?

MS. WEISS: Yes. I would like to talk briefly off the record.

(Bench conference.)

DR. JORDAN: Had you finished your reply to counsel's question?

WITNESS CLARK: No, I had not.

DR. JORDAN: I want to bring up something but after you finish.

WITNESS CLARK: I believe I had reached the point of saying that ultimately reliance must be placed on the operator. Since that is the case, you must be very careful to not add to the system devices which will make it more complex, which themselves introduce further possibility of failure within whatever you have added, and which further complicate the ability of the operator to comprehend what is happening and to decide when and how he should intervene when that point arrives.

It is particularly important not to introduce so-called interlocks which not only complicate the ability to understand what is happening, but have the ability to prevent the operator from in fact taking actions in the event of an unforeseen sequence and keep him from doing what you would want him to do in that situation.

Therefore, as an underlying philosophy in my experience I believe underlying the whole nuclear power industry is that you only have automatic controls, or circuits, or interlocks when you believe you cannot rely upon the operator because he does not have adequate time or he does not have adequate information.

I believe this position is supported by the vast bulk of all the investigations of the TMI-2 accident. All of those speak heavily to the need for enhanced operator training, for the need for better procedures, for the need for the operator to have the basic understanding of the plant and of heat transfer, and other theoretical bases. And to my knowledge, none of them speak to the need to prevent the operator from being able to take action or control in any situation where you can reasonably believe that he has the time and the information which he would need to exercise that control.

MR. BAXTER: The panel is available for cross examination.

DR. JORDAN: Let me just -- I said I might have one question.

I guess my experience has been more with protective systems and I would surely be dismayed to see the argument made that the number of signals that call for a scram should be greatly reduced or possibly eliminated, because it is better to have the operator take the action.

I have no quarrel with seeing the operator have the option of manually scramming a reactor when he thinks it is necessary, but for him to say -- try to do what the scram system does would be in my mind wrong.

I realize that you have said now when he has time, and so I have not had time to think about that. But typically then in the case of the protection system, what you said does not apply to that, I presume.

WITNESS CLARK: No I would not imply that the reactor scram should be -- that you should rely on operator action for a reactor scram; and the reason is, as you identified yourself, the time allowed to detect the situation and cause the scram is such that you would like to rely on an automatic system.

Also, as you indicated, there are diverse signals, any one of which would require the reactor scram and therefore would not be proper to rely on the operator to see all of those signals or monitor all of those variables within a timely enough way to rely on him to scram.

I think the discussion in this contention goes in a time frame much l nger than that to after you have had a trip, and you have observed the plant, you know, and looked at the parameters, you know, is it then proper and allowable to rely upon the operator. So you are right, what I said should not be interpreted to apply to reactor trip.

DR. JORDAN: But supposing the trip was coming from a signal which could not possibly be hi,h radiation level in the turbine room is a ridiculous example, but something that was not cured. Most of the things that cause a trip, of course, are automatically cured by the trip itself, and so therefore there is nothing to stop the operator from again, as you say, trying to start the reactor. And if it occurs again he will get another trip.

But I would be concerned about him deciding, say, well, that high radiation level or that high temperature in some spot is a false indication. I think we ought to remove that from the trip system. That kind of an operator action is one I would be particularly worried about.

WITNESS CLARK: I am having trouble thinking about a tie-in between a high radiation --

DR. JORDAN: It is a ridiculous thing. It does not happen, of course.

WITNESS CLARK: Clearly you require trained operators. You require that there be time for them to think, to consult procedures for their supervision, to operate, what have you. But ultimately you reach a point where you require the operator to take correct action, and the judgment that is involved is how much automatic equipment you provide because it does tend to undercut the operator's ability to understand and decide what actions should be taken in those cases where he will have to act.

DR. JORDAN: Okay. Then I guess we will be facing shortly the matter that has been up in front of us for several days, and that is automatic action on the emergency feedwater system.

I believe it has been pointed out that there is plenty of time for the operator to take the action of turning on emergency feedwater, and there is plenty of time for him to control it; and so therefore it would be your position that that is better than to have automatic actuation of the emergency feedwater.

WITNESS CLARK: Yes, sir.

DR. JORDAN: All right. I understand.

CHAIRMAN SMITH: Ms. Weiss.

CROSS EXAMINATION

BY MS. WEISS:

Q Mr. Patterson, you were asked about Mr. Pollard's testimony, in particular a statement that the choice of words in IEEE 279 was heavily influenced by reactor shutdown systems. You made some rebuttal to the effect that there were engineered safety features other than reactor shutdown systems in place at some reactors at the time IEEE 279 was written and also at the time its revision was issued in 1971, and so there was experience with engineered safety features other than reactor shutdown systems.

But do you disagree with the statement that the choice of words in IEEE 279 was heavily influenced by the experience with the reactor shutdown systems?

A (WITNESS PATTERSON) No, I disagree. I do not think they were heavily influenced, because they were enunciating principles, and those principles would apply to the transport system as well as they would to nuclear power.

Q The vast majority of experience was with reactor shutdown systems.

A (WITNESS PATTERSON) Beg your pardon?

Q The vast majority of experience was with reactor shutdown systems during the period of development of IEEE 279.

A (WITNESS PATTERSON) I don't believe you can categorize the work being done by any of us at that time as being primarily with that. We were dealing primarily with nuclear safety, and there was not a division -- the departmentalization of work as is there today.

Q And it is wrong that most of the experience of these people who were concerned with reactor safety, particularly in the period 1964 to '68 when that standard was under development, it is wrong that most of their experience was with reactor shutdown systems? That is not an accurate statement?

A (WITNESS PATTERSON) I am having a little trouble hearing you. It was wrong that what?

Q Are you saying that it is wrong that during the period of development of IEEE 279, that is, roughly 1964 to 1968, that most of the experience of the persons on that committee was with reactor shutdown systems?

A (WITNESS PATTERSON) I guess what I am trying to say, it is wrong to categorize the experience as all being heavily weighted on one side.

Q Can you -- is it possible for you to give an answer to the question as I stated it? In other words, you may disagree -- are you still having trouble hearing me?

A (WITNESS PATTERSON) I am having trouble hearing you. That is the problem.

(Discussion off the record.)

CHAIRMAN SMITH: Ms. Weiss, I think that your question could be worded better, and I think there is some confusion in the question. It is a rather long one.

BY MS. WEISS: (Resuming)

Q Let's step back a couple of steps and see if maybe we don't disagree on everything we think we disagree on. Isn't it correct that during the period of development of IEEE 279, roughly 1964 through 1968 -- that is the period of development, is that correct?

A (WITNESS PATTERSON) That is what?

Q That is the period of development of IEEE 279.

A (WITNESS PATTERSON) Yes, principally.

Q Isn't it accurate that the general experience of those on the committee drafting IEEE 279 during that period, that most of the experience was with reactor shutdown systems?

A (WITNESS PATTERSON) I am having a problem with the "most" bit because it sounds exclusive, and I guess what I am trying to point out is it is not "most" in the sense that we did not have knowledge of other things. Certainly reactor protection systems were the main subject we were dealing with, yes.

Q By "most" I did not mean all. I meant the majority.

A (WITNESS PATTERSON) Yes.

Q Did you testify, Mr. Patterson, that IEEE -- are you still having trouble?

A (WITNESS PATTERSON) Yes, a little bit.

Q Put your hand up if you cannot hear me. Was it your testimony that IEEE 603 will be issued in final form next month?

A (WITNESS PATTERSON) It was approved in I believe it was March of this year as a full standard, and it went to the printer, and the printer has been having some trouble. The 1980 issue is due out any time now, yes.

Q Could you tell me if there are any significant changes in the language of 603 that is quoted in Mr. Pollard's testimony or any changes at all?

A (WITNESS PATTERSON) The only thing that I have seen, Ms. Weiss, is the draft that went to the printer; but my recollection was that none of the document that Mr. Pollard had referred to, that those parts are the same in the new version as they were in the draft standard.

The principal change in it has been the de-emphasis of 279 or replacement of 279.

Q And the intention now is for IEEE 603 and IEEE 279 to both exist, is that what your testimony was?

A (WITNESS PATTERSON) Yes. They will co-exist in the future.

Q Mr. Clark, you testified that it is important for the operator to have flexibility to deal with accidents that go beyond the design basis accident. That is an accurate statement of your testimony, isn't it?

A (WITNESS CLARK) That was a part of my statement on that point was that the operator requires flexibility to deal with whatever may occur.

Q Can you tell me -- well, strike that. However, for design basis accidents I take it -- and this question is probably better directed to Mr. Ross -- I take it that you feel you have, with B&W's help, analyzed all those plant transients and accidents and developed operator procedures which will enable you to cope with all of those. That is correct, isnt it?

A (WITNESS ROSS) It is correct as we know it today, yes.

Q And you do not expect -- and those procedures are mandatory on the operator. They do not allow improvisation. That is correct, isn't it?

A (WITNESS ROSS) I don't understand.

Q We are going to get into that more in detail when we get to that portion of your testimony, but in general the procedures are quite specific. In other words, do not throttle high pressure injection until the following specific plant conditions are met.

That is correct, isn't it?

A (WITNESS ROSS) That is correct.

Q And he is instructed to follow those directions and not to depart from them, isn't that accurate?

A (WITNESS ROSS) That is accurate.

Q And that would cover design basis accidents, yes?

A (WITNESS ROSS) Yes, it would.

Q So your concern for allowing operator flexibility has got to be limited to accidents which go beyond the design basis, isn't that correct, Mr. Clark?

A (WITNESS CLARK) No, it is not correct.

Q You mean you foresee certain situations occurring covered by operator procedures where the operator would have the authority to depart from those procedures.

A (WITNESS CLARK) I believe it is just as impossible to foresee all possible sequences of events and reduce them to operating procedures as it is to foresee all possible sequences of events and reduce them to automatic circuitry.

Q Well, would you disagree with Mr. Ross that your operator procedures cover at least all design basis accidents?

A (WITNESS CLARK) Design basis accidents are a defined class, and they typically are worst case or extremes rather than being all possible gradations, and they explicitly do not allow for every possible failure or sequence of failures. That is why you have procedures which tell the operator to see if this is the case, then do that, that sort of thing.

Q Okay. But in terms of defining, particularly focusing your attention on defining the conditions for termination of safety systems, it is your opinion that those conditions have been defined for all design basis accidents. They are included in your operator procedures, and the operator is told to follow them in all situations, is that correct?

A (WITNESS CLARK) All of the design basis accidents have been analyzed, procedures have been developed to provide guidance to the operator as to what to do in the event of all such accidents.

Q And that guidance is mandatory. It does not allow for improvisation, particularly with respect to the conditions for terminating safety systems.

A (WITNESS CLARK) The operator is to follow the procedures as written.

Q In all cases?

A (WITNESS CLARK) The operator is to follow the procedures as written.

Q In all cases?

A (WITNESS CLARK) I would like to develop my thinking and continue to answer the question if I could, please. The operator is to follow the procedures as written with one overriding principle which is that in the event that in his judgment safety of the public or personnel requires him to do something not in the procedure, he should so do.

Q Would you tell me in what part of the operator training the operator is told that there are certain conditions during which he may depart from the procedures?

A (WITNESS CLARK) I cannot give you a specific reference to that.

Q Are you aware that the operator is instructed specifically along the lines that you just told us? Do you think this is something that he knows, or is he told you may depart from the procedure if certain conditions exist?

A (WITNESS CLARK) I believe he is told he is to llow the procedures in all cases unless he believes that the safety requires him in an immediate sense to depart from it.

Q Is he told what indications he is to rely on in order to give him the knowledge that the public safety is imminently in danger such that he should depart from his procedures?

A (WITNESS CLARK) We are talking about situations which are unforeseen. We believe that the design basis analyses cover the events which he will encounter and that the procedures cover those events. However, when you ask for an absolute statement that the operator is told never to do something that is not in the procedure, I cannot answer that affirmatively but only as I have just answered it.

Q Well, isn't it accurate then going -- we have gone full circle -- that your desire for operator flexibility or your statement that operator flexibility is a desirable or a necessary goal applies only to accidents beyond the design basis?

A (WITNESS CLARK) No.

Q Perhaps you could give me an example of an accident --

MR. BAXTER: Excuse me, Mr. Chairman. I would like the witness to be able to finish his answer before the next question.

BY MS. WEISS: (Resuming)

Q Please continue.

A (WITNESS CLARK) No, because your question talks about being beyond the design basis, and I believe that that has connotations and use elsewhere, I wou. say, rather than your term beyond the design basis not explicitly covered by the analyses or the procedures.

Q Not explicitly covered by the --

A (WITNESS CLARK) Analyses or procedures unforeseen.

Q Is it your understanding that there are some design basis accidents that are not covered by the analyses and procedures?

A (WITNESS CLARK) No.

Q No?

A (WITNESS CLARK) By definition, "unforeseen" precludes there being some that I am aware of.

Q Could you repeat that last answer again?

A (WITNESS CLARK) Yes. The term "unforeseen" precludes the inclusion of those things of which I am aware.

Q Precludes, okay. Then I am not sure I understand that, but let me ask the question again. You do understand or it is your opinion that the operator procedures cover all design basis accidents.

A (WITNESS CLARK) Yes.

Q Can you give me an example of a design basis accident for which the operator is given flexibility in the determination of emergency safety systems?

A (WITNESS CLARK) Loss of coolant accident.

Q And what flexibility is he given with respect to terminating the safety systems?

A (WITNESS CLARK) As defined in our direct testimony, he is given the flexiblity to throttle high pressure injection flow provided defined conditions are met.

Q But he is not given the flexibility to throttle high pressure injection flow before those specified defined conditions are met, is he?

A (WITNESS CLARK) The procedure requires that one of those three sets of conditions be met before he can throttle the flow.

Q So would you define the -- define what you mean by flexibility in that case?

A (WITNESS CLARK) I am not sure what you are getting at.

Q Well, you agree with me that the operator is given defined and specified conditions, and he is not permitted to throttle high pressure injection until those conditions are met. Would you then define for me what is the nature of the operator's flexibility in a loss of coolant accident?

A (WITNESS CLARK) I believe that you introduced the term "flexibility," that I did not introduce it in this discussion. Perhaps what you are driving at is that as compared with a situation in which the system would not allow him to throttle high pressure injection flow, we believe that he should have the flexibility to throttle it when those conditions exist.

Q If you don't like the word "flexibility," let me substitute "exercise in judgment."

Now, you have agreed with me that the operator is under no conditions for any design basis accident permitted to throttle high pressure injection until specified conditions are met. Would you please tell me where the room is for exercise of operator judgment?

A (WITNESS CLARK) The operator -- I am worried about the term "judgment" and how you may mean it. He is required to exercise judgment in one sense in determining that those conditions are met. He is not allowed to exercise judgment in the sense of deciding to take action contrary to those conditions being met.

Q Okay. So the operator is told just to verify that the conditions are met, and then at that point -- from that point on his course of action is wholly proscribed.

A (WITNESS CLARK) The procedure, I believe, tells him to throttle flow so as to maintain a certain degree of self-cooling. For example, it is proscribed to throttle flow. It is his experience and judgment to determine how to do that so as to maintain the required conditions.

Q Did you say it his experience and judgment how to throttle high pressure injection?

A (WITNESS CLARK) The extent to which to throttle it so as to maintain the required conditions.

Q But these -- this judgment, this area of judgment which you have described is an area of judgment which does not come into play until the specified conditions are met, correct?

A (WITNESS CLARK) Yes. The judgment of how to throttle flow does not apply until you start throttling the flow.

Q And what is -- would you describe for me what the exercise of judgment is, if there is any, in verifying that the conditions are met?

A (WITNESS CLARK) I think in a real sense it is very limited in the sense that it is proscribed for him which parameters to look at and what values they should be, greater or less than some value.

Q For these unforeseen events for which you think it is desirable to have operator flexibility or room for the exercise of judgment I take it that these are events which have not been identified or analyzed by the Babcock and Wilcox Company, the General Public Utilities Company, the Metropolitan Edison Company.

A (WITNESS CLARK) Yes. As I said earlier, by definition "unforeseen" means that.

Q Do you have any idea what the probability is that such an event would occur?

A (WITNESS CLARK) No. I am not a statistician. I believe, however, that the probability of an unforeseen event occurring is greater if you had more systems and more complication and more things which can go wrong.

Q Well, with Three Mile Island Unit 1 as currently designed, do you have any opinion or did you consider when you were writing your testimony what the probability is that this unforeseen event, unforeseen by Babcock and Wilcox, GPU, and Met Ed, will occur?

A (WITNESS CLARK) I personally did not consider it in a numerical sense, the probability. In a generalized sense, based on experience, I considered it to be not insignificant, and therefore deserving of consideration before deciding to add automatic features.

Q When you say "not insignificant" do you have any qualitative notion of probability in mind? Do you mean greater or less probable, for example, than one in a million per reactor year?

A (WITNESS CLARK) I have no number in mind, only a relative probability between the situation in which you would have automatic circuitry and that in which you would not have it.

Q I am sorry. We did not hear the automatic. What was that?

A (WITNESS CLARK) I said I have no numeric value in mind for probability, but only a relative probability between the two cases, one where you would have the system as at present, and the other where you would have the system with added complication.

Q I am just asking you about TMI-1 as it exists now.

A (WITNESS CLARK) I had already answered that I had no numeric value in mind.

Q Let me ask you this. Presumably the probability that this event which has as yet been unforeseen by everybody is far lower than the probability of a design basis event which has been foreseen. Wouldn't you agree with that?

A (WITNESS CLARK) Well, for any given unforeseen event I would agree. For the generic class of unforeseen events I would not agree. I would reserve judgment.

Q Do you have any idea of how many man-hours of technical effort was spent by Babcock & Wilcox analyzing what they consider all possible accidents and transients?

A (WITNESS CLARK) In a general sense, large.

Q And do you believe that if Babcock & Wilcox has not been able with that large number of highly technical man-hours to foresee this event that the operator in the midst of it can be expected to take appropriate action?

A (WITNESS CLARK) Yes, I do.

Q Do you have any evidence of that?

A (WITNESS CLARK) Yes. I think experience, and my own personal experience derives from the Navy program. Experience shows that with time, previously unforeseen events occur, and properly trained operators have properly dealt with them.

Q Your experience from the military, did you ever become aware of studies of subjecting highly trained military recruits to simulated emergencies for the purpose of comparing their response to their training?

A (WITNESS CLARK) I am not aware of those specific studies?

Q Would it surprise you to know that one-third of all such trained persons fled in panic from simulated emergencies?

MR. BAXTER: Objection, Mr. Chairman. If the witness is not aware of the studies, he does not know what kinds of simulations they were, what kinds of emergencies there were. I don't see how he can form a judgment.

WITNESS CLARK: I was about to make a similar comment, that I would have to know what the simulated emergencies were in order to form an opinion whether I was surprised or not.

CHAIRMAN SMITH: Sustained.

(Laughter.)

BY MS. WEISS: (Resuming)

Q Mr. Clark, looking at your statement of qualifications -- just one second, please.

(Counsel for UCS conferring.)

Q Looking at your statement of qualifications I note that you have been with GPU for I guess a little less than a year, nine months or so, is that correct?

A (WITNESS CLARK) Yes.

Q And would it be accurate to describe your responsibility for all three GPU reactors as a managerial one?

A (WITNESS CLARK) The term "manager" is used by many people in widely different senses. I am and consider myself, and always have, primarily an engineer who is in management as opposed to some other definitions of "management."

Q Okay. Did you ever work, prior to this job with General Public Utilities, with any commercial nuclear facility or commercial nuclear utility?

A (WITNESS CLARK) Naval Reactors, as you may be aware, is responsible for the Shipping Port Pressurized Water Reaction Plant. While that is owned and operated by the Department of Energy -- it is owned by the Department of Energy rather; it is operated by Duquesne Light Company as a commercial reactor plant.

My responsibilities within Naval Reactors included responsibility for the Shipping Port plant for the past 15 years or so.

Q Exactly what was your day-to-day contact with the Shipping Port facility?

A (WITNESS CLARK) I guess it could be perhaps best described as visiting a number of times a year, reviewing technical matters having to do with it, and you know, this is obviously a judgment, I did not, you know, keep a book on it, perhaps every week or two weeks. It also included, and I think perhaps pertinent to this discussion, subsequent to the accident at Three Mile Island I was in charge for Naval Reactors for reviewing the implications to the Naval Reactors program of the Three Mile Island accident.

Q Would you say -- were you involved in the design of Shipping Port or any other commercial facility?

A (WITNESS CLARK) I was not involved in the original design of the Shipping Port plant, some of which predated my joining Naval Reactors, and I was not involved in the early days. I was involved in the design of the modifications made to the Shipping Port plant, primarily in safety systems in conjunction with the insertion three or four years ago of a new core; and that involved upgrading of the emergency core cooling systems -- for example, remote shutdown stations, things of that kind.

Q What is the size -- did I interrupt your answer?

What is the size of the Shipping Port plant?

A (WITNESS CLARK) It is rated -- the original rating was 50 megawatts electrical with capacity to allow it to go to 150 megawatts electrical; and it is has been operated up to 150 megawatts electrical. And sometimes it has been operated lower.

Q And that has been in operation since when?

A (WITNESS CLARK) 1957.

Q Is that a boiling water reactor, pressurized water reactor?

A (WITNESS CLARK) Pressurized.

Q And who were the builders of that reactor then?

A (WITNESS CLARK) The reactor was designed by a government laboratory operated for us by Westinghouse. I make that as a distinction from the commercial Westinghouse reactor group.

Q And is the Shipping Port -- your experience with Shipping Port your only direct job-related experience with a commercial nuclear facility until you came to GPU?

A (WITNESS CLARK) In the sense of direct responsibility, yes. In the sense of familiarity and awareness with requirements of commercial reactors, no, because we made it a practice to be aware of the requirements of commercial reactors in order to determine any applicability to our own plants.

(Counsel for UCS conferring.)

Q Are the design criteria used by the Division of Naval Reactors identical to those used -- I'm sorry, you cannot year?

DR. JORDAN: You slipped up on my, kind of.

MS. WEISS: I am sorry.

BY MS. WEISS: (Resuming)

Q The question is whether the design criteria used by Naval Reactors are identical to those used on civilian plants?

A (WITNESS CLARK) No.

Q Have you ever performed a safety review or part of a safety review for any commercial facility, for any safety system?

A (WITNESS CLARK) For Shippingport, yes. In a very limited sense, since coming to GPU, in the sense of modifications being made to the plant, yes.

(Counsel for UCS conferring.)

Q Are the criteria used for Shippingport identical to those used for Three Mile Island?

A (WITNESS CLARK) No. Shippingport, the basic plant predates Three Mile Island by many years and the criteria have been evolving.

Q In fact, I think that Shippingport may have predated the general -- promulgation of the general design criteria; is that correct?

A (WITNESS CLARK) I do not know the date of the general design criteria.

Q Do you know, Mr. Patterson?

A (WITNESS PATTERSON) Yes, you are right. It predates that. The general design criteria came out just prior to -- 2/29/68.

A (WITNESS CLARK) The modifications made to Shippingport in '67-'68 postdate the general design criteria and much of what we did was reviewed by the NRC and by the ACRS before we installed the new core, and I am sure were judged by us and by them in light of the then existing general design criteria.

Q Did you have personal responsibility in an engineering sense for the design of these modifications to Shippingport?

A (WITNESS CLARK) I had personal responsibility for the reactor, which includes the core, pressure vessel head, and control drive mechanisms; and had responsibility to concur in the adequacies the safety systems which were installed.

Q Did Shippingport have an emergency core cooling system at the time it began to operate?

A (WITNESS CLARK) Yes.

Q What was the exact nature of the modification?

A (WITNESS CLARK) I think in the sense you ask it the nature of the modification was to improve the reliability of the power supply and to provide increased redundancy for some portions of the fluid system. And if I recall properly -- this may have been a prior modification. That is the reason I hesitate. It was not all done at once -- to provide for improvements in the control of the boron concentration in the fill water.

I guess the other one was the remote operating station or equivalent.

Q Were your duties for the Navy primarily concerned with the reactors for the nuclear submarines and nuclear surface vessels?

A (WITNESS CLARK) I had responsibility for all the reactors for the Navy. Numerically, the Navy reactors, you know, were far greater in number than Shippingport. Because of its uniqueness, the fact that different criteria did apply and other factors, why, I would say that Shippingport proportionally got a greater share of attention than one out of so many.

Q Can you give me an estimate of what percentage of your working time when you were associate director for the Naval Reactor Division was spent on Shippingport and how much was spent on the other reactors?

A (WITNESS CLARK) I guess I would divide it into three parts. Let's say up to about eight years ago, 5 percent. From eight years ago until about two years ago, where we were heavily involved in designing a new reactor, which was a breeder reactor, why, that 5 percent perhaps went to 15. And if I take the time after the TMI-2 accident until I left the Navy, why, probably half of my time was devoted to understanding the TMI-2 accident and the lessons from it and attempting to apply them to the naval program, including Shippingport.

(Counsel for UCS conferring.)

Q These are the percentages of time spent on Shippingport?

A (WITNESS CLARK) Yes, ma'am. I believe that was the question; was it not?

Q Yes, it was.

Can you tell me what the differences in design are between the naval reactors -- and for simplicity's sake, exclude Shippingport from those, for the next series of questions until I tell you otherwise. What are the differences in design between the naval reactors and commercial reactors?

A (WITNESS CLARK) I will necessariy have to be general to avoid a classification problem.

Q Yes.

A (WITNESS CLARK) Naval reactors are designed for -- I think the differences can be seen best, perhaps, by thinking about the design requirements. Naval reactors are designed for underwater shocks. So where a commercial reactor is -- seismic requirements of perhaps 1.25, 1.50 g, 1.50 times the weight of it, the Navy would typically be greater than 20 g.

Where the requirements for maneuvering of civilian plants are typically to come to full power perhaps over a couple of hours or something of that sort, the requirements for the Navy are to maneuver much more rapidly.

I think the differences arise largely from those more stringent requirements on the naval plants.

Q Is it also true, in the same general vein in which you have been talking, that since the wellbeing of the crew of the ship depends on the operation, continued operation of the reactor, that that continued operation is an overriding goal in design and operation of the naval reactors?

A (WITNESS CLARK) I do not believe that is a correct characterization. Naval reactors are required to operate in port. The public health and safety -- if you were to pick an overriding consideration, I think it would have to be the public health and safety.

Q I am sorry. I am having a hard time hearing you.

A (WITNESS CLARK) If you were to pick an overriding consideration, I think it would be public health and safety.

Q This is for the naval reactors?

A (WITNESS CLARK) Yes, ma'am. Is that what you asked me?

Q Yes. But at least during the times when the ship is at sea, there really is no corresponding public to consider, as there is with a commercial reactor?

A (WITNESS CLARK) In a general sense, the way that was dealt with was to allow modified requirements to apply at sea, compared with the operation in port.

Q Then with the qualification that this applies primarily when the ship is at sea, isn't it true that the overriding consideration becomes keeping that reactor in operation?

A (WITNESS CLARK) You have to say the overriding consideration in what? The overriding consideration in devising the procedures and requirements for operation at sea would be correct to say what you did. In the sense that the design of the plant and the procedures for operation in pa t, it would not be correct to say what you did.

Q Would it be generally accurate that the naval reactors are both smaller and less complex than the commercial, typical commercial reactor?

A (WITNESS CLARK) They certainly are smaller, and there are -- in terms of being more complex, there are pros and cons to that. If for a commercial plant, you take the normal commercial -- the normal power operation and for a minute exclude auxiliary facilities such as disposing of radioactive wastes and things of that kind, which perhaps could be viewed differently, I think if anything the commercial plants would be more complex.

But there are systems and components in the naval plants which do not exist in commercial plants. So it is not all one way.

Q Could you directly compare, without getting us into classified information, the complexity of the emergency core cooling systems for naval reactors on the one hand and commercial plants on the other?

A (WITNESS CLARK) I am not sure in what sense you want me to compare them. They clearly are different in size. I think perhaps it would be more difficult to compare the emergency core cooling of Shippingport, and I would say that that is quite comparable.

Q Well, is it true that the ECCS systems on submarines are quite a bit less complex than the ECCS systems on TMI-1?

A (WITNESS CLARK) On submarines, yes. Surface units, yes, but to a much lesser degree. And at Shippingport, as I said, I think they are basically comparable.

Q Mr. Ross, a couple of questions on your qualifications statement. You note that you graduated in

1951 from the U.S. Navy Nuclear Prototype School. Which prototype school was that?

A (WITNESS ROSS) Bainbridge, Maryland.

Q What sort of reactor?

A (WITNESS ROSS) Pardon me?

Q What sort of reactor?

A (WITNESS ROSS) S5W. They really taught a basic nuclear power plant system, is what they really taught.

Q Do the letters and number "S5W" stand for anything in particular?

A (WITNESS ROSS) I think it would suffice to say it would be standard naval nuclear plant.

Q Designed by Westinghouse?

A (WITNESS ROSS) Yes.

(Counsel for UCS conferring.)

Q Mr. Patterson, I would like to direct your attention to page 3 of your testimony, please. In the last line of that page, quote: "In support of this position, it should be noted that the 1971 issue of IEEE 279 clarified the portion of Section 4.16 cited by UCS to read."

And then on the next page you give the new language or the language with the addition.

Could you tell me first precisely what position you were saying this change in language supports?

A (WITNESS PATTERSON) The paragraph above that, Ms.

Weiss, is the one that that refers to, where I say that Section 4.16 of 279 as cited by UCS is therefore applicable only in the context of this protection system's scope.

Q Would you tell me exactly -- well, can you tell me -- go on to page 4. Can you tell me what the language of Section 4.16 looks like before the change?

A (WITNESS PATTERSON) Yes. The language of 4.16 before the change essentially said that a protection system action shall go to completion. And after the change it said a protection system action at the system level shall go to completion. That was the major change, the inclusion of the words "at the system level."

Q It was my understanding that the purpose of that change was to clarify that if only one signal out of four on a protection system indicated a need to actuate the system, that that signal did not have to be locked in, that it was -- that the change was intended to say you do not need to lock in the signal until you get two out of four. Is that correct?

A (WITNESS PATTERSON) I think that was what brought on the -- there was some confusion in the original criteria as to how it would apply to a multiple channel system.

(Counsel for UCS conferring.)

Q So the purpose of the change was to clarify that a spurious signal did not have to be locked in. That is correct, isn't it, a one-channel signal?

A (WITNESS PATTERSON) Yes, except there is an exception to that, again. As I said, as long as there is redundancy in the system, which means that a single channel can trip and that does not go anywhere, that does not have to be locked in.

Q Would you tell me, then, how the change in language supports your position that the section is applicable only in the context of your definition of protection system?

A (WITNESS PATTERSON) The difference between what happens in the IEEE 279 '68 version and the IEEE 279 '71 version is slightly changed, but there is no change in scope.

Q Then would it be accurate that the change in language has no effect whatever on the scope?

A (WITNESS PATTERSON) The change of language did not have a change -- an effect on the change in scope. But it was also during that revision period, the authors did not feel that there should be a change, either.

Q Are you saying that you infer from the fact that certain sections of the standard were changed, that certain sections that were not changed were reaffirmed?

A (WITNESS PATTERSON) Basically, yes.

Q Are you aware of whether Metropolitan Edison committed at the operating license stage for Three Mile

Island Unit 1 to comply with IEEE 279 1968?

A (WITNESS PATTERSON) Am I personally aware of that? I have heard that statement. I have no personal firsthand knowledge of that.

Q You have heard that that is correct?

A (WITNESS PATTERSON) I have heard that that is correct, but I have no personal firsthand knowledge.

Q Does anybody else on the panel have anything to contribute on that question? You don't know, Mr. Clark?

A (WITNESS CLARK) No.

A (WITNESS ROSS) I don't know.

(Counsel for UCS conferring.)

Q B&W supplied a portion of the plant, obviously, for TMI. Do you know whether B&W committed to meet IEEE 279 for Three Mile Island Unit 1?

A (WITNESS PATTERSON) The only portion of the protection system that I am aware of or would know about on TMI-1 was the reactor protection system. That was designed and built to IEEE 279 1968.

Q May I direct your attention, Mr. Clark, to page 4 of your testimony, the fifth line after your testimony starts on that page. You state that: "Providing automatic circuitry to prevent the operator from modifying a particular action once it has been initiated is impractical and would seriously complicate the plant and detract from safety."

Before I begin, do you understand -- the UCS Contention was intended to apply only to protective actions which are automatically initiated? Did you understand that? Is that how you understood the contention?

MR. BAXTER: The contention says "safety functions."

MS. WEISS: Can the witness answer the question?

WITNESS CLARK: We read it -- and we will reread it -- as being general. I do not believe it says automatically initiated. I don't recall it as saying that.

BY MS. WEISS: (Resuming)

Q And you are not aware --

A (WITNESS CLARK) Excuse me. I reread it. My recollection was incorrect. The contention does say "initiated automatically."

Q My question was, is that what you understood at the time you wrote your testimony? Would it have any bearing whatever on your testimony?

A (WITNESS CLARK) I wrote the testimony directly after reading the contention. That is what I understood at the time of writing my testimony.

CHAIRMAN SMITH: I think you pointed out the need for some clarification on your contention. It is true that the basis refers to a safety function which is initiated automatically. But your final sentence, your conclusion, does not limit that to an automatic safety function.

MS. WEISS: Well, but the section --

CHAIRMAN SMITH: I think a fair inference is you may have intended it.

MS. WEISS: This section of IEEE referenced refers only to automatically initiated safety systems.

CHAIRMAN SMITH: In any event, that is what you intended with the contention?

MS. WEISS: Yes. There has been quite a bit of discovery on it. I just do not want to -- I wanted to make sure there was no misunderstanding when the testimony was written.

CHAIRMAN SMITH: Would you object if we inserted the words "automatically initiated safety function"?

MS. WEISS: You could, on the last line of the contention, that could be changed to read: "The design must be modified so that no operator action can prevent the completion of a safety system once automatically initiated."

MR. POLLARD: Could we come back to you with the language?

CHAIRMAN SMITH: Good thinking.

MR. BAXTER: We are going to get a new contention after the recess? Is that what I understand?

MS. WEISS: Did you misunderstand it, Mr. Baxter?

MR. BAXTER: I don't believe I did.

MS. WEISS: I don't believe you did, either.

CHAIRMAN SMITH: It will be a narrower contention, and that is almost an absolute right.

BY MS. WEISS: (Resuming)

Q Would you define, please -- back on this general section of your testimony -- define what you mean by "impractical"?

A (WITNESS CLARK) There are at least two elements to that. One is the one we discussed earlier, in terms of the inability to foresee all possible situations. The other has to do with the number of original circuits or what-not which would be involved in trying to do that, even for those that could be foreseen.

Q We have talked enough about No. 1. Let's talk about No. 2. There are indications in the control room already, the circuitry in the control room, covering all the parameters which comprise the conditions necessary for terminating safety systems; isn't that correct?

A (WITNESS CLARK) Yes. I will qualify that to my personal -- to the three systems cited in the contention which I have reviewed. I have not presently reviewed the other systems.

Q So you already have signals driving meters in the control room. Where is the additional complexity involved in using the same signals, in wiring them into the control circuits for the equipment used to throttle, for example, high pressure injection?

A (WITNESS CLARK) I think it might be useful and directly responsive to that question to take one of these and start to think, what is involved in the word "interlock." The signals involved in the determination of emergency core cooling are on the order of eight temperature indications from the plant, several flow indications, and several pressure indications. And the criteria given to the operator to terminate the emergency core cooling or to throttle are three, A, B, or C, each of which involves comparing several of those signals.

In order to prevent the operator from taking action to throttle, you have to take the signals which already exist at the meter, run them somewhere else, provide logic, equipment to compare them for each of the three cases, and to compare the three cases to see that you meet one of the three, and then take that signal to some position and some device which, if the logic is not satisfied, would defeat any operator attempt to take an action.

(Counsel for UCS conferring.)

On reflection, to add to that, failure of any of th[illegible] wires or interlocks or devices would now add an additional possible factor to be considered [illegible]y the operator. Since you want the operator to monitor and see that the systems are working properly, you would then likely require indication to him of the proper performance of the devices I just described. So that you would be adding further indication or alarm or ability to determine what was going on to that with which the operator already has to deal.

BY MR. POLLARD:

Q Mr. Clark, just so it is less time-consuming in the hearing, I will just take over for Ms. Weiss and follow up on what you started here.

Are you referring -- when you talk about the conditions for throttling high pressure injection, am I correct that you are referring to the conditions which are set forth in Emergency Procedure 1202-6B on page 8, which is UCS Exhibit 6.

A (WITNESS CLARK) I was referring in the first instance to those filed by Mr. Ross. I am not sure that that is the right number or not that you gave me.

MR. BAXTER: Mr. Pollard, when you said page 8 you meant page 8 of the testimony, didn't you?

MR. POLLARD: Page 8 of the procedure.

CHAIRMAN SMITH: Are we going to need this to follow this, Mr. Pollard? Our copies are back in the file.

WITNESS CLARK: I believe they are the same as in the testimony on page 8.

MR. POLLARD: I will work from the conditions that are in the prefiled testimony on page 8.

BY MR. POLLARD: (Resuming)

Q If you take condition A, which states the LPI system is in operation and flowing at a rate in excess of 1,000 gallons per minute in each line, and the situation has been stable for 20 minutes. Mr. Clark, what information does the operator have to verify that the flow rate is in excess of 1,000 gallons per minute in each line?

A (WITNESS CLARK) I do not remember the exact indication, but he does have indication, a meter, a dial, a readout of some kind, which shows him flow rate in the low pressure injection lines.

Q And what information does he have to determine that the situation has been stable?

A (WITNESS CLARK) He has available to him all the indication in the control room. I would expect that the operator would refer primarily to temperatures and pressures in the primary and secondary plant.

I think perhaps that is illustrative of another element of what is practical to define for an automatic system. The word "stable" I think you can define for an operator and he can exercise a judgment as to whether it is stable. And that is a lot harder to build into a circuit.

So perhaps that is a third element to my answer to Ms. Weiss' earlier question.

Q Is it not possible that the operator could interpret that sentence to mean that the 1,000 gallons flow per minute has been stable?

A (WITNESS CLARK) I do not like to deal with the word "possible," because in one sense anything is possible. So in that sense, yes, it is possible. I do not think it is likely.

I think that if the intent, and if the operator were to interpret it that way, it would say that the flow has been stable for 20 minutes.

Q In other words, you are saying that this procedure leaves it up to the operator to decide how to determine whether the plant -- whether the situation has been stable?

A (WITNESS CLARK) Yes.

Q And I assume for the 20-minute part of that instruction he has some sort of a clock?

A (WITNESS CLARK) Yes.

Q Now, for instruction B, is it not correct that the operator would have saturation meters to determine whether the temperature is at 50 degrees below the saturation temperature?

A (WITNESS CLARK) The operator would have a saturation meter available to him. His instructions in this and other emergency procedures are to not rely on the single indication where multiple indications are available, and therefore he is trained and instructed to look at all available indication, which would include the saturation meter or meters, the hot and the cold leg temperatures in each of the loops, which I think in the control room there are four from each loop, four from each hot leg in the control room and two from each cold leg in the control room, something like that.

And we would expect him to look at those as well as the saturation meter.

Q You are aware, are you, that the saturation meters use those temperatures and pressures as inputs?

A (WITNESS CLARK) Yes, I am. I am also aware of the fact that the saturation meter is no more infallible than any other device. And we consider it proper for the operator to consider all the information available to him in making a determination such as intervening in a safety system such as with this. And he is so instructed explicitly.

Q So it is possible, if we had a failure on a temperature instrument which indicated a lower temperature than actually existed, and that temperature instrument supplied input to the saturation meter, the saturation meter would also indicate more of a saturation margin than actually exists, and therefore the operator would have two wrong indications?

A (WITNESS CLARK) For the failure you describe -- well, first, he would have one wrong indication in the temperature detector which you have postulated to have failed. He would also have available and be relying on the order of seven or eight other temperature indications, all of which presumably have not failed at the same instant.

In terms of the saturation meter, I do not recall whether it relies on a single temperature indication or not. I am inclined to believe that it does not, but I am not certain of that. If it relied on a single one and that was the one which had failed, then it would be an error. If it relied on multiple indications and all had not failed, then it would not be in error.

I just am not certain on the facts on that.

Q Do you know whether all of the temperature indications and pressure indications, flow indications, which are available to the operator, which you have testified he has available to consult, are all safety grade?

A (WITNESS CLARK) I am not personally certain of that fact. I would expect they are, but I have not personally verified that.

Q For item C or instruction C, would you agree that a device which has to compute the allowable pressure-temperature region would be at about the same complexity as a device which has to compute the saturation margin?

A (WITNESS CLARK) I am not certain. They both involve monitoring and comparing pressures and temperatures. However, I believe the allowable pressure-temperature region definition, or a calculation thereof, would likely involve some allowance for thermal lag or for temperature difference between the point at which you are measuring it and the point of interest, which is the reactor vessel wall.

So I believe there may well be an additional factor or factors in the pressure vessel temperature comparison which would not exist in the saturation meter device.

Q Perhaps I phrased my question incorrectly. Have you examined figure 2, and you are generally familiar with what it looks like?

A (WITNESS CLARK) Yes.

Q Do you think that curve is roughly the same as you might see if you looked at the steam table curve of saturation versus temperature?

A (WITNESS CLARK) Yes.

Q Then you would agree, if you had to design a device to simulate that curve, it would be of about the same order of complexity as the saturation meter?

A (WITNESS CLARK) Yes. My earlier comment was aimed more at devising this curve than at monitoring it, once devised.

Q Now, considering the information that is available to the operator and on which he is going to base his decision as to whether or not the plant is in a condition which permits throttling of the high pressure injection, why do you believe that the situation is less desirable if you then take that same information and physically incorporate it into the circuit such that the operator cannot throttle high pressure injection until those very instruments tell him that it is permissible to throttle high pressure injection?

A (WITNESS CLARK) As I discussed earlier, it is impossible to foresee all sequences of events. So that is a general concern about doing what you said.

We also talked about the definition of "stable," and in order to meet criterion A you would have to devise a definition of "stable" which you are satisfied covered all conditions and could be reduced to elements introduced within an automatic circuit. I think those are perhaps two main elements of the concern.

Q In other words, you believe the hardware needed to define "stable" is a complex set of equipment?

A (WITNESS CLARK) I believe that for any definition of "stable," it might be relatively complex or less complex. I believe that the ability to define in advance for all possible circumstances and sequences of events what stable is, such that it could be understood by a device, is impractical.

Q But you nevertheless believe that the operator would be able to figure this out?

A (WITNESS CLARK) Yes. I think inherent in this whole argument is that a trained operator, a properly educated and trained operator with the guidance and the practice on the simulator and everything else that goes with it -- and we really ought to think of operator as the operating staff, and the operating staff today includes so many RO's, CRO, shift technical adviser, what have you, that the operating staff has a greater capability to deal with the unforeseen, the unimagined, the unusual, than any preprogrammed device.

And I believe that that is inherent, because they have available to them all the information of what is actually showing up, whereas in order to preprogram it you have to conceive all possible calculations of what may be showing up, and that is at the heart of the impracticality.

MR. BAXTER: Mr. Chairman, I am sorry to interrupt. I would like to propose at a convenient point that we take our mid-afternoon break. I don't want to interrupt if there is a line Mr. Pollard wants to conclude.

CHAIRMAN SMITH: Okay, let's take --

MR. POLLARD: I don't have many more questions on this line. If I could just complete this. Probably less than five minutes.

CHAIRMAN SMITH: All right.

(Counsel for UCS conferring.)

BY MR. POLLARD: (Resuming)

Q Am I correct in interpreting sort of your bottom line conclusion of your testimony, on the one hand you are balancing having the availability for the operator to make judgments for unforseen sequences of events as an advantage -- you are balancing that against the disadvantage -- excuse me.

You are balancing that against a system which would have the advantage that he could not terminate high pressure injection for all foreseen events?

A (WITNESS CLARK) I have a little trouble following that.

Q I had a little trouble asking it.

A (WITNESS CLARK) I believe the answer is yes, that it is better to rely on the operator where there is time available and proper information available to him than it is to attempt to provide automatic means which would prevent him from acting. And I believe that is the same as what you said, in a little different words.

BY MS. WEISS: (Resuming)

Q I think you probably are answering the question right, but just so the record is clear, let me try to restate it. On the one hand, you have a system where the operator is prevented from prematurely terminating a safety system for all design basis events. On the other hand, you have a system where the operator is not prevented from terminating the safety system for all design basis events, and he is permitted the flexibility of dealing with unforeseen events.

Those are mutually exclusive systems. In your view, balancing the advantages of one against the other, it is better to have a system which permits you in unforeseen events to have operator flexibility than to have a system which prevents you from having operator error for foreseen events.

A (WITNESS CLARK) I believe the answer to that is yes, that is what I believe. There is one clarification I would suggest to what you said at the beginning, though. You said, to have a system which prevents the operator from intervening for all design basis events, and I am not aware of any such system.

It would be a system which prevented the operator from intervening for all events, design basis, i.e., foreseen and unforeseen, and the system would be unable to discriminate between those two classes of events.

Q Yes, you are correct.

MS. WEISS: This is a break point.

CHAIRMAN SMITH: All right, we'll take a ten-minute break.

(Recess.)

CHAIRMAN SMITH: Are we ready to begin?

BY MS. WEISS: (Resuming)

Q Mr. Clark, on the top of page 5 of your testimony you say that "From the very beginning of the nuclear power industry the plant operator has been recognized as a required element to correct plant operation. It has always been recognized that it would be impossible to construct a plant which would operate correctly under all conditions, and that a properly trained operator control of the plant is the best continuing guarantee of correct operation."

What is the source of your information on the very beginning of the nuclear power industry?

A (WITNESS CLARK) I think that that goes to the original design of the Shipping Port plant, and while I was not directly involved personally in the original design of the Shipping Port plant, I was involved for many, many years with the people who did do that design, including the man who was in charge of it. And they were very free with the fact that that underlay their approach from the very beginning. It also underlay, although I think perhaps less pertinently, the Navy approach.

I think if you take the old ways, it comes on up through things like the 603 document which has been introduced in the testimony of [illegible] Pollard, where I believe it is in Section 310, desi[illegible] -- it requires in the design basis that you define the following, and 310 is the critical points in time or the plant conditions after the onset of a design basis event. And then it goes to itemize, and I would like to refer to item D first.

Item D says, "The point in time or plant conditions which define the proper completion of the protective action at the system level," so you have to predefine the conditions or the time that that is the completion of the protective action.

Item C, a distinct item, requires you to define the conditions after which a deliberate operator intervention may prevent the completion of protective action at the system level. So that 603 clearly recognizes a distinction between those conditions which define completion of protective action and those conditions which should allow operator intervention.

Q Does 603 allow operator intervention before the completion of the safety function?

A (WITNESS CLARK) 603 requires the designer to define both sets of conditions independently of one another. I think there is a fairly clear inference that if the operator were not to be allowed to intervene before the completion of the safety function, it serves no purpose to define those conditions separately.

You could merely state that once the safety function is complete, he is allowed to intervene. So I think there is a very strong suggestion that because they are defined separately, the operator intervention can precede the other set of conditions.

I am not sure whether I should continue to finish the answer to that.

Q Please feel free.

A (WITNESS CLARK) Okay. I think a third element in that is the studies after TMI-2 -- and I refer specifically to Kemeny, Rogovin studies as two of the major studies -- have a heavy emphasis on the requirement to educate the operator, the requirement to give him well-defined procedures, the requirement for training, and do not have any such emphasis or, to my recollection, any recommendation that steps should be taken to prevent operator intervention.

So I would suggest and believe that those studies support the statement that, you know, this has been an underlying approach from the beginning up until the present time.

Q Do you know if anything in any of those studies supports the proposition that an operator can compensate for poor design or ought to be used for poor design?

A (WITNESS CLARK) There are two different questions.

Q I would like you to answer the second one, please.

A (WITNESS CLARK) I certainly don't recall anything in the studies -- and if there were, I would not endorse it -- which says that you should use the operator to compensate for poor design in the sense of intentional. I believe that if there were a poor design that a good operator in fact in practice could attempt to compensate for it. However, that is not something that one should rely upon in developing or accepting a design.

Q In preparing your testimony did you refer anywhere to IEEE 603 -- your prefiled written direct testimony?

A (WITNESS CLARK) To the best of my recollection I did not. 603 was brought to my attention by review of Mr. Pollard's direct testimony which, as I recall, were filed subsequent to my filing my own.

Q Let me direct your attention to page 6 of your testimony at the very top. Actually, I should probably begin at the last sentence on page 5 when you say that "Subsequent bypass of such circuits, on the other hand, proceeds on a much more deliberate basis. The operators have ample opportunity to verify that the conditions prerequisite to bypass are in fact met. They can, as appropriate, refer to written operating procedures and/or consult with their immediate supervisor prior to activating the bypass."

Isn't it correct that the reference to written procedure and the consultation with supervisors would be solely for the purpose of verifying that the conditions prerequisite to bypass are met?

A (WITNESS CLARK) I would be hesitant to say that an operator in an emergency would consult solely on any narrowly defined things. I think he would consult with his supervisor on the situation, certainly including what you said. But to, you know, state that he would not consult on anything else, I would be unwilling to so state.

Q But at least with respect to all design basis accidents, this consultation would not include consulting about modifying or waiving emerg ncy procedures in any way.

A (WITNESS CLARK) The primary basis for the consultation should be, and I believe would be, with regard to whether the requirements of the procedure are met. Again, to say that something would not happen, you know, I do not think really I should be expected to say that nothing else would be discussed.

Q Let's go on to the examples that you discuss on page 6. Is it your testimony -- you list fix examples on pages 6 and 7. Is it your testimony that these are all examples of cases where the operator has to intervene before the specified plant conditions have been met for termination of safety systems?

A (WITNESS CLARK) No, it is not.

Q Which of the examples are situations where the operator must intervene before the plant conditions for termination of safety systems have been met?

A (WITNESS CLARK) None of them.

Q In that case didn't you understand that the UCS contention would permit the operator to terminate the safety function after the plant conditions are met?

A (WITNESS CLARK) Yes, I did understand that.

Q And these examples are not inconsistent in any way with the UCS contention.

A (WITNESS CLARK) They are inconsistent in a sense that your contention is automatic circuitry ought to be provided to prevent them from intervening before that. And what we are saying is that to add such circuitry is unnecessary and has the disadvantage of further complicating the plant, introducing the possibility of additional errors, failures, or unforeseen sequences and making it impractical for the operator or tending to make it impractical for the operator to understand and diagnose the situation and take proper action.

Q Have you listed any case at all, given any example at all where adding the circuitry that UCS suggests would prevent the operator from taking an action necessary for public health and safety, on the assumption that the circuitry operates as designed?

A (WITNESS CLARK) No

CHAIRMAN SMITH: When you were referring to plant condition, Ms. Weiss, could you give me a better explanation, both of what you meant and what the witness understood you to mean?

MS. WEISS: I referred to the plant conditions listed in this testimony by Mr. Ross on pages 8 through 10; that is, the conditions necessary for termination of ECCS, the conditions necessary for termination of emergency feedwater, the conditions necessary for termination of containment isolation.

CHAIRMAN SMITH: So you would not disagree then with Mr. Clark that the operator could throttle, for example, HPI when condition A was met, on page 8, for example?

MS. WEISS: We take no exception with the definition of the conditions which would permit the operator to terminate the safety system.

DR. JORDAN: I am really having a little bit of a problem, I must admit, understanding where there is a difference between Mr. Clark and, say, Mr. Pollard. I suppose it is understanding what is meant by "completion." The IEEE 279 as quoted in the contentions says that the protection systems shall be so designed that once initiated the protection system action shall go to completion.

Well, I think that Mr. Clark did have some further definitions of what he meant by "completion," but he never, I do not believe, said that the operator should stop the action before arriving at his point, what he meant by completion.

Now, if that -- is there a difference of opinion between Mr. Pollard and Mr. Clark as to what "completion" is?

WITNESS CLARK: Could I attempt to clarify that?

DR. JORDAN: I would invite both you and Mr. Pollard to help, and Mr. Sholly I also saw shaking his head.

WITNESS CLARK: I believe there are two distinct bases for judging the appropriateness of what we propose, and that there is a great tendency to mix them, and that that does not contribute to understanding.

I refer to the first basis as the standards, 279, 603, the regulations as explicitly defined. It is our position that the standards as written quite clearly define completion of protective action as getting the signal to the pump or the motor and do not bear on the further operation.

DR. JORDAN: Okay. Then there is a genuine difference. You would say getting the signal to the control rods to drop is enough, whether they drop --

WITNESS CLARK: No, no, no. All I am saying is that 279 very explicitly does not carry the argument beyond that point, so where an argument is to be based on the standard I believe it is quite clear that the standard limits itself to the scope I just described.

There is an entirely separate argument as to what is proper for safety, and that is covered by a lot of other standards, by judgment, by practice, but the standard itself is quite limited.

DR. JORDAN: I don't see how you say that. Are you looking at that one statement in the contention, "Protection systems shall be so designed. Once initiated protective" -- do you disagree with that as a standard?

WITNESS CLARK: I agree with that statement which is extracted from 279.

DR. JORDAN: All right.

WITNESS CLARK: And I agree that when you read all of 279 it says, "The protective system goes from the sensor to the terminal on the pump or valve," and that it says, "Completion of protective action as discussed in 279 is for the signal to get from the detector to the terminal."

279 literally does not itself address anything thereafter.

DR. JORDAN: Are you saying 279 therefore is deficient?

WITNESS CLARK: I am saying 279 had a limited scope, that there are other standards and requirements which apply. There are general design criteria. There are other things. But that an argument which says take 279, intentionally written and limited by the authors to this part of it, and say it applies to more, that that is an improper argument. That the argument based on the standard is invalid because the standard limits itself to a very small part of the whole problem; that the remaining argument then is what is proper, needed, right -- you know, whatever term you want to use -- or is covered by things other than 279.

DR. JORDAN: So it is not so much the contention itself as written that your problem is but rather it was Mr. Pollard's testimony concerning that contention.

WITNESS CLARK: The statement that 279 prohibits what we are saying should be allowed, we believe that statement is incorrect and that 279 does no cover the ground.

DR. JORDAN: All right. I think I am beginning to understand it.

Mr. Pollard, do you have disagreement now?

MR. POLLARD: Dr. Jordan, I will take my opportunity when I am on the stand.

DR. JORDAN: All right. Okay.

CHAIRMAN SMITH: If we want to know now, I think we can find out now. It is okay.

MS. WEISS: Let me say something and then if you want to --

DR. JORDAN: I don't want to prejudice Mr. Pollard.

CHAIRMAN SMITH: I don't think we have to worry about it. I would like to know what the positions are now.

MS. WEISS: I will tell you.

CHAIRMAN SMITH: If he needs relief he can ask for it.

MS. WEISS: Our position is -- and I think that Mr. Clark has accurately broken the question into two parts. Our position is not -- strike that.

Let me state it in the positive sense. Our position is that IEEE 279 both has been interpreted beyond -- to apply beyond the point where he says it is stopped, and we give examples in our direct testimony of ways in which it has been applied beyond the narrow scope that the licensee and the staff limited it to. But more importantly that one -- what we believe one of the primary Lessons Learned for Three Mile Island accident is that it should be so interpreted, and we have given you a piece of testimony that goes over the history of the development of the standard, plus what we believe to be some appropriate insights drawn from the accident to support that general argument.

DR. JORDAN: That sounds reasonable to me, what you are saying, but then aren't you saying IEEE 279 should be reinterpreted or rewritten?

MS. WEISS: I think our position is IEEE 279 as properly interpreted would call for what we have called for.

DR. JORDAN: All right.

CHAIRMAN SMITH: Now, to get back to my earlier question, my question was what was meant by -- what did you mean by "plant condition," and that has never gotten answered.

MS. WEISS: The plant conditions are all of the conditions listed in their testimony which permit termination of the safety systems.

CHAIRMAN SMITH: Okay, then. So you would agree that once initiated, the HPI could be terminated by the operator when the three conditions on page 8 are satisfied. That is your position.

MS. WEISS: Exactly.

MR. POLLARD: Any one of them.

CHAIRMAN SMITH: Any one of them.

MS. WEISS: The contention is the plant should be designed so the operator can terminate it before the conditions are met, but he is perfectly free to terminate it after those conditions are met.

DR. JORDAN: That helps me to understand. I was puzzled by that. It was a contradiction I could not understand.

Mr. Sholly, did you have something you wanted to add to that?

WITNESS CLARK: Could I comment on one thing that was just said with regard to the fact that 279 has been interpreted as applying more broadly than I said, and I suggest that that is not a proper characterization. There are a lot of standards an sources of requirements of which 279 is one. It very clearly limits itself to the scope I have described.

It is true that some of the things, the principles, if you will, in 279 have been applied elsewhere. I believe that is different than saying that 279 itself has been applied elsewhere.

CHAIRMAN SMITH: Mr. Clark, what is your position -- excuse me for not picking it up, but what is your position for the example of throttling of HPI? Do you believe that the operator should be given the power to throttle the HPI before any one of those conditions on page 8 are met?

WITNESS CLARK: No. It is our position that the operator should throttle HPI after one of those conditions is met. That is the way our procedures are written. The point in controversy is whether you provide automatic means to prevent him from intervening earlier, or whether you rely on him to not intervene earlier.

CHAIRMAN SMITH: Yes, I understood that to be the controversy. But my question was do you think that he should, under any circumstances, throttle the HPI before any one of those three conditions are met?

WITNESS CLARK: I think that he should have the flexibility to so do for some unforeseen event which would make that a proper thing to do.

Now, the question came earlier, and perhaps I could address it now, where does it say the operator is required to do whatever he thinks is necessary for health and safety. And it is in our administrative specifications for the station which say that in the event the plant is in a condition or state of parameters outside of those defined or foreseen, that it is not only allowable but required of the operator to take those actions which it considers necessary for health and safety. So that where he faces a situation which has not been foreseen and the actions proscribed for him, he is in fact required to do what he believes is necessary. And it is in the admin spec.

CHAIRMAN SMITH: Yes. I understood all that part of your testimony. I was trying to understand your testimony in the context of specific examples.

WITNESS CLARK: It is in our administration specifications.

DR. JORDAN: I guess then that the question that I asked the other day, almost inadvertently, with respect to another contention is really one that applies here, and that is, should the saturation meter be hooked up in such a way as to prevent the operator from withdrawing -- turning off the high pressure injection system. So I think that perhaps the line is kind of drawn there. All right.

BY MS. WEISS: (Resuming)

Q Let me ask you this, Mr. Clark, just to follow up on what Mr. Smith asked you. You said you found some place in your procedures where the operator is told he is supposed to do what is right for health and safety. But I think the more pertinent question is when he is in a situation which is unforeseen by any of the procedures and which is not covered by his training, how does he know what is the appropriate thing to do to protect public health and safety?

A (WITNESS CLARK) I think you are correct in characterizing this as a situation which is not covered by the procedures. I do not believe it is correct to characterize it as one which is not covered by his training.

One of the main lessons from TMI and one that is being put into effect is to substantially broaden the training of the operators to provide them training in heat transfer and thermal hydraulics and understanding of the plant systems for interaction and response.

Additional action has been to provide to the operator additional expertise in the form of the shift technical adviser who is there as a resource on whom the operator can call, just as he could go to the procedures or what not. So the operator is trained to deal with these situations, even if they are not covered by the explicit procedure.

Q He is trained to deal with unforeseen events?

A (WITNESS CLARK) Yes. He is trained with the fundamentals, the understanding of heat transfer, of system interactions, etcetera. And that is the only training that you can give and that does provide proper basis for him to evaluate what is happening and decide what to do.

Q Now, these operators are still high school graduates or equivalent. I take it this is training that Met Ed or GPU gives them.

A (WITNESS CLARK) It is training for our operators we give. The training itself is based on reviews we have had made by I believe it is Penn State and a committee of educators and engineers from other universities. And it includes input from the Babcock & Wilcox Company with regard to what do you have to understand. It includes looking at the program of training provided to naval operators with which many people in the nuclear program are familiar.

And while not explicitly training, I think appropriate to the question of will he be able to decide what to do, there has been added the shift technical adviser, who is a graduate engineer, is available to the shift crew to provide advice in any situation they wish.

Q How many --

CHAIRMAN SMITH: You also depend, don't you, upon the fundamental difference between men and machines, the ability of man to assert his ability to reason and think, and a machine can only do what it is programmed to do.

WITNESS CLARK: Yes, sir. I think that is fundamental for the whole discussion, that for the unforseen, the unpredicted, the human being with a proper background is clearly superior to a machine.

DR. JORDAN: For some things, but for some things machines are very clearly superior to men.

WITNESS CLARK: Yes, sir. I intended to say "for the unforseen," and I think that is a key element. The other two key elements we talked about earlier were time and information.

DR. JORDAN: Yes, you did emphasize that, and you did say that it is difficult to design equipment that will take care of unforseen situations. It is also, however, difficult to write procedures and train operators to handle unforseen situations, too. And to that extent, I guess I think your additional comment that they have the technical competence now, in addition to the ordinary operator training, is probably a significant advance.

WITNESS CLARK: Yes, sir. We think the shift technical adviser is, you kno , a significant improvement today as compared wit the pre-accident situation.

CHAIRMAN SMITH: May I amend my question to refer to the difference between persons and machines.

(Laughter.)

WITNESS CLARK: May I so amend my answer.

(Laughter.)

(Discussion off the record.)

BY MS. WEISS: (Resuming)

Q How many hours of training in thermal dynamics do your operators get now?

A (WITNESS CLARK) I am not certain of that. I would prefer to have Mr. Ross address it. I have reviewed it, but I do not remember the number.

Q Fine.

A (WITNESS ROSS) The number I don't have right on the tip of my tongue. It is in our other transcript we will be presenting on operator training.

A (WITNESS CLARK) My recollection, subject to verification, is 60 hours of basic theory, if you will, of thermal hydraulics. I am not absolutely certain of that, which is why I tried to defer. It is not 6 hours or 10 hours.

DR. JORDAN: Is it in the restart report?

WITNESS CLARK: I would think so. It is part of the operator accelerated retraining program. I would think it certainly is in there.

BY MS. WEISS: (Resuming)

Q I would just like to pursue this point about the difference between persons and machines. With the understanding that we are talking here only about unforeseen events, it is also people, very highly trained people like Mr. Jones who testified here the week before last, who has spent what you described as a large amount of time attempting to identify all possible accident transients -- plant accidents and transients -- is it correct that your testimony is that the operator and his shift technical adviser, with their 60 hours of training --and the shift technical adviser has more -- are going to be in a better position to diagnose a plant condition and prescribe corrective action than all those highly trained personnel at Babcock & Wilcox?

A (WITNESS CLARK) I am not suggesting that the operator and the STA are more highly qualified to diagnose and develop corrective action for a specific condition. What I am saying is that it is a very different problem to attempt to foresee and predict all possible conditions than it is to deal with a specific existing condition on which you are receiving information.

And so it is not proper to say I believe the on-shift people are more qualified. But it is more proper to say that they face a much reduced problem with dealing with one specific situation on which they have a lot of information. And that is far different from trying to foresee and predict everything that could possibly happen.

Q And it is also people like Mr. Jones -- I assume Mr. Jones is one of them -- who have decided what goes into the operator training and procedures, or have done the work fundamental to that.

A (WITNESS CLARK) I am not certain whom you mean by "Mr. Jones."

MR. BAXTER: Mr. Jones, for your information, was the B&W witness who presented their small break analyses and operator guidelines developed from this analysis.

WITNESS CLARK: I don't not know whether Mr. Jones or other, what I will describe at perhaps some risk of being too narrow on them as analysts, whether he or people like him were involved.

The training program was developed with input, I do know, from people like Penn State professors in terms of, you know, how to scope it, how to present it, how to make it an effective program with input from operators, both our own operators and engineering people in our company and elsewhere who have been operators. For example, people who, with an engineering degree, then went through the naval program and were operators.

BY MS. WEISS: (Resuming)

Q You don't know that the work done by Babcock & Wilcox was analyzing small break LOCA's -- was primarily done for the purpose of writing the new operator procedures and training?

A (WITNESS CLARK) I do know that that work was considered very thoroughly in writing the procedures. I was not here when it was started, so I would not care to comment as to whether it was done primarily for that purpose or not.

Q That at least was the source of the definition of plant conditions permitting termination of safety systems, wasn't it?

MR. BAXTER: Are you speaking of the emergency core cooling system now or all safety systems?

MS. WEISS: Emergency core cooling system.

WITNESS CLARK: In developing our definition and the procedures, we certainly relied on those analyses done by B&W of the loss of coolant situations.

(Counsel for UCS conferring.)

CHAIRMAN SMITH: Ms. Weiss, there is another aspect to this controversy that I want to see it I could get some explanation on. Is it UCS's position that automatic safety systems as they exist now should not be interruptible by operators? Or is it that safety systems should be designed with the thought in mind that operators will not interrupt them?

MS. WEISS: Well, I guess the contention is the former. I think the latter would be a better situation, probably, in terms of engineering. But the contention is the former.

CHAIRMAN SMITH: Does anybody's testimony address the problem that I would assume would be faced, that safety systems are, I would assume, designed with the idea in mind that operator action may be depended upon in unforeseen circumstances?

Am I making my point clear?

MS. WEISS: I think I understand what you are saying. That's what we were trying to get at today with the questions establishing the fact that all of the instrumentation and the circuits are already available on the control room to indicate to the operator when the conditions are met. We were discussing what the complexity would be to wire those circuits directly into the safety system, so they would prevent the safety system from being terminated before those conditions were met. That was the purpose of those questions.

CHAIRMAN SMITH: But what I mean, going back to the fundamental concept that the designer had in mind when he was doing the different things that designers do, didn't he having lurking someplace in the back of his mind, or she, as the case may be, the thought that, well, if this doesn't work, there is always an operator around that will interrupt it and -- you don't know?

MS. WEISS: I really don't know.

WITNESS CLARK: I think what I was suggesting in my testimony and some of the cross-examination is very clearly people have always had that in mind, and it is implicitly recognized in the standards, such as 279 and 603.

BY MS. WEISS: (Resuming)

Q Can you tell me, Mr. Clark, if what the Chairman just mentioned may have affected the design in any way?

A (WITNESS CLARK) Yes. For example, we do not have an interlock such as is being suggested.

Q I think the question was, is there something -- interrupt me if I stat it correctly. I understood your question to be, is there something inherent in the design, for example, of the emergency core cooling system which requires oper tor intervention?

CHAIRMAN SMITH: Not requires nor prohibits, but uses as a design boundary the ultimate reliance upon operator interruption if thi:;~ go wrong.

MS. WEISS: I hope you will ask us that question tomorrow.

CHAIRMAN SMITH: Well, yes.

WITNESS CLARK: Do you desire that I respond to that?

CHAIRMAN SMITH: Yes, please, anybody.

WITNESS CLARK: I would say yes, in a broad sense. And I will try to illustrate it, that it would be possible to design a reactor plant which would be smaller, more compact, would have less mass and fluid volume in it, and would therefore respond much more quickly and would require the provision, therefore, of more automatic circuitry; and that inherent in the kinds of designs we have is a recognition or a belief or a desire that you ought to provide in the basic design sufficient inherent capability or give or margin to allow for a limited amount of automatic circuitry and recognize that the operator was available thereafter.

Specifically on these plants, on the TMI plant, I can describe this in words. The temperature at which the plant operates is lower at zero power than it is above 15 percent power. One reason for that is to allow for the retention in the steam generator of a volume of water at low power, which will serve as an initial heat sink, cooling mode, et cetera.

So that instead of designing the plant to operate and probably make it a little smaller, to operate with, you know, essentially no water left in the steam generator at zero power, it is designed and built and operated to have some water in the steam generator, even at zero power. That may not be the best example, but I think it is an example, and the general concept is proper.

And for example, that is why, if you go to look at something like aircraft nuclear propulsion, it would never really get off the ground, if you will excuse the pun, because it required taking all the margin out of it.

CHAIRMAN SMITH: Sorry to interrupt.

DR. JORDAN: Off the record.

(Discussion off the record.)

BY MS. WEISS: (Resuming)

Q That example that you just gave was an example of, as I understand it, an aspect of the design which assumes that there will be an operator?

A (WITNESS CLARK) Yes.

Q But it does not -- it does not -- it is not an example of an instance where operator action is needed during an accident before the stabilization of the plant?

A (WITNESS CLARK) The question was, I thought or understood, are there examples in the design where you know the design is based on assuming there will be an operator, and that is what I tried to answer. I think it is not unrelated to the question, however, of allowing operator intervention in the case of an accident or allowing the operator to do something in the case of an accident. Because you have the water in that steam generator, the pace of the action is moderated such that there is sufficient time for the operator to take required actions, and therefore you are not required to introduce the quicker-responding automatic circuitry.

Q But the fact that the water is in the steam generator in no way prevents the operator from making an error. In your viewpoint, it may mitigate the consequences of making an error, but it does not prevent him from making an error?

A (WITNESS CLARK) It provides the operator with sufficient time to be able to understand what is happening and take proper action, and therefore it tends to keep him from making an error. I would not argue that it absolutely prevents him from doing so.

(Counsel for UCS conferring.)

Q But the fact that that water is in the steam generator does not of itself -- does not really have any bearing on the question of whether termination of safety systems ought to be automatic or ought to be controlled by the operator? In other words, that fact does not affect the question one way or another, does it?

A (WITNESS CLARK) I think it does, in the sense that the Chairman asked the question, are we dealing with plants which fundamentally and overall were designed with the assumption that there would be operators and that they would be relied upon?

Q But you -- I mean, you are dealing with a specific plant. But the fact is you have not pointed out any aspect of the design which would make it necessary for the operator to intervene to terminate a safety function before the plant is stable, have you?

A (WITNESS CLARK) I am trying to recall all we have discussed, and I am not sure whether we have introduced a specific or not. I believe that it may have been introduced in testimony I read by perhaps the NRC witness on the failure of --

Q No, no, please.

A (WITNESS CLARK) I don't think I have introduced a specific example today.

Q My question was just -- that also extends to your example about the water in the steam generators?

A (WITNESS CLARK) Yes.

Q That sho-' as my questions some.

(Counsel for UC. conferring.)

Q Your example, your first example on page 6, you state that without the operator action to terminate ECCS flow, large quantities of water containing some amount of radioactivity would be released into the outer containment building, requiring cleanup actions and some degree of personnel exposure.

That description is a description of a bleed and feed mode of cooling, correct?

A (WITNESS CLARK) The distinction between the case I am discussing here and the bleed and feed mode of cooling is that in this case it would be unnecessarily so.

Q But in terms of the operator of the system, the water needed to be cleaned up and the personnel exposure, it is precisely the same as bleed and feed, correct?

A (WITNESS CLARK) In terms of the elements you mentioned, it is the same. There is another distinction, and that is that if you did not throttle flow for a small break LOCA, not only would the water get out, but it could well get out by lifting the safety valves, and any challenge to a safety piece of equipment which is unnecessary is a detriment to safety.

CHAIRMAN SMITH: I am sorry to interrupt again, but it was this very mple which prompted me to interfere before. When I saw this example, I wondered how you disagreed with page 8, the items on page 8, which would allow, according to the Union of Concerned Scientists, throttling when one of three conditions are met, safe shutdown, not to the point where you dumped water all over the containment floor.

MS. WEISS: That is correct, and that is why I say the questions are shortened. This is really a different sort of a point.

The next question was whether the testimony -- whether it is his judgment that there is some safety disadvantage associated with bleed and feed.

BY MS. WEISS: (Resuming)

Q You can answer that question.

A (WITNESS CLARK) I am sorry. Would you restate the question?

Q Is there some safety disadvantage associated with the cleanup actions and the personnel exposure and the amount of -- the liftup of the safety valves which you described, which is associated with bleed and feed?

A (WITNESS CLARK) I think "disadvantage" by and large implies a comparison. Disadvantage relative to what? I think in the sense of your question I would respond that I consider the bleed and feed to be a satisfactory means of cooling the core. It is not the preferred means.

The preferred means is, you know, to have the system intact, and then you go from there to others. But I think it is a perfectly satisfactory method.

Q And your second example, which is the opening of containment isolation valves after their automatic closure to take samples of the primary coolant. It was my understanding that one of the requirements from the lessons learned from TMI was that you be able to take samples without opening any main containment isolation valves; isn't that correct?

A (WITNESS CLARK) There are lessons learned requirements for taking samples after an accident. I do not recall this minute whether it covers both primary coolant and containment. And I would have to be refreshed on that.

I think it is also, however, pertinent to note that whenever you take a sample, there is always a question as to how representative that sample is. And it is certainly conceivable, and I guess in my opinion fairly likely, that it would be desirable to take samples, perhaps once you know what the situation is, from another location, or that there would be some failure which would preclude your ability to take it where you had intended.

I think what we are saying is that you do not want to create a situation in which it is impossible to take a sample if the occasion arose.

Q Would you tell me specifically what containment isolation valve in TMI-1 which automatically closes during an accident must necessarily be reopened to take a sample?

A (WITNESS CLARK) I am not familiar enough to identify the specific valve. I would believe that there might well be more than one, and that it would depend on what kind of sample, you know, where you had best access to it and things of that kind.

I think that in a way illustrates the difficulty of imposing automatic means, because that would require you to define which of those you wanted to do when, and I am suggesting that you cannot do that.

Q Did you have in mind when you wrote the testimony, or do you know if there are at Three Mile Island Unit 1, any containment isolation valves which automatically close during an accident, which must be reopened to take a sample?

A (WITNESS CLARK) I do know there are containment isolation valves which do automatically close which, if opened, would allow you to take a sample. That is the basis for the testimony.

Q No, no, that is not the question. Do you know whether there are any such valves that must be opened to take a sample?

A (WITNESS CLARK) I guess that means, is there any way to take a sample from containment without opening a valve.

Q Aren't you required to have means of sampling without opening the containment isolation valves?

A (WITNESS CLARK) I am not certain of the facts. My instinct is that you cannot -- well, I think almost by definition you cannot take a sample without opening a valve, else you would have an open path from the containment to outside.

So I think on that basis I would say I would have to go look at all the diagrams to know, or perhaps Mr. Ross could answer that question.

Q Before you go to Mr. Ross, I want to make it clear that I am talking only about valves which are automatically isolated on containment isolation. You had no particular valves in mind when you read the testimony. That is what I gather from what you are saying.

A (WITNESS CLARK) When I wrote the testimony, I reviewed with the engineering people working for me what the cases were. I do not recall at this point what the specific one was.

Q But there was one at the time?

A (WITNESS CLARK) That is my recollection.

Q Do you know what that might be, Mr. Ross?

A (WITNESS ROSS) Yes, I do. I don't know from what regulation you quote the fact that you must not be able to open a containment isolation valve to take a sample.

Q I am talking only about valves which are automatically closed.

A (WITNESS ROSS) I don't know what regulation you quote from when you say that. Valves at Three Mile Island that are automatically closed on the containment do isolate some primary coolant.

Again, I say I don't know what regulation you specify that requires not being able to open an automatic valve to take a sample of the reactor coolant system. I further go on to say that I think the requirement is more that diverse isolation signals be required to isolate those valves.

Q Can you tell me which valves you had in mind?

A (WITNESS ROSS) Yes, to draw a sample in the primary coolant system there are three isolation valves involved. They are coolant sampling valves 1, 2 and 3. To draw a sample in the steam generator, there are a total of four valves involved. To draw a sample in the core flood tank, there are two valves per tank involved that have an ES signal to them.

Q These are valves which receive automatic signals on --

A (WITNESS ROSS) They are. They receive diverse signals on containment isolation.

Q And those are -- those are valves which you envision being opened during the accident before the plant is stable, to take those samples?

A (WITNESS ROSS) We never did say that we envisioned them being opened before the plant is stable. We further said, the requirements based on reopening them. That is all we stated.

Q The requirements are stated on reopening them after the conditions are met for termination of the containment isolation system.

A (WITNESS ROSS) The requirements are that you be able to open them to take a sample with an approved procedure that those valves initially isolate on a diverse isolation signal, which in our plant will be a reactor trip signal.

Q And the situation you are envisioning is one where they reopen after the accident is over, or after the plant is stable?

A (WITNESS ROSS) Or perhaps some time during the accident when the information is of need to us, and we specify that they should be opened in accordance with approved procedure.

(Counsel for UCS conferring.)

Q There was a review which was done of post-accident sampling after the accident at Three Mile Island Unit 2. And some of the conclusions of at least the preliminary review are contained in NUREG-0578, the short-term lessons learned. Is that your understanding?

Are you aware that generally post-accident sampling was one of the issues raised by the Three Mile Island accident?

A (WITNESS ROSS) Yes, specifically shielding of it.

Q And you were directed that if personnel could not promptly and safely obtain samples when necessary, additional design features or shielding should be provided. Do you recall that?

A (WITNESS ROSS) I do.

Q What is the instrumentation in the control room to tell the operator that these samples can be safely obtained?

A (WITNESS ROSS) In our change mods that are being installed on the plants, there is a number of new radiation monitors being installed. These radiation monitors will monitor various lines to have samples and/or sump lines.

Also, those same lines, the isolation valves in them, will give a diverse isolation signal, one of them being reactor trip.

Q So in no case would you send somebody to take a sample until that radiation monitor showed that it was safe to do so.

A (WITNESS ROSS) Again, we would by our procedures only obtain a sample in accordance with an approved procedure. That approved procedure would state the necessary radiation requirements.

Q Right.

A (WITNESS CLARK) I would suggest that in terms of safety of personnel going to take a sample, that there would be local radiation monitoring as the sampling station was appproached, and that reliance would not be placed solely and perhaps not even primarily on installed radiation monitors reading in the control room.

Q But it would be placed on some radiation monitors?

A (WITNESS ROSS) Consideration would definitely have to be given to the radiation levels in the area.

Q Right.

MR. BAXTER: Mr. Ross, just for the record, you used the term "mod." What is that an abbreviation for?

WITNESS ROSS: I am sorry. "Mod" is modification. When I refer to a mod, I am referring to a change modification being installed in TMI Unit 1.

BY MS. WEISS: (Resuming)

Q Your example number 4 on overfilling, I just have one clarifying question. I take it from what you said today that it is not your opinion that operations at the 95 percent level on the steam generator operating range is a dangerous condition? You don't believe that, do you?

A (WITNESS CLARK) I am not sure I understand your reference to 95 percent operating range of the steam generator.

Q Let me backtrack a little.

A (WITNESS CLARK) If you mean at 95 percent power, no, I don't believe that.

Q No, no. 95 percent steam generator level on the operating range.

A (WITNESS CLARK) I would not believe that operating the steam generator level within the allowed operating range is unsafe.

Q So if the circuitry were designed so the operator could terminate emergency feedwater after the 95 percent level, but he could not terminate it before the 95 percent level, there would be no danger of overfilling?

MR. BAXTER: Do you mean above and below?

MS. WEISS: I am sorry. Did I say that backwards?

MR. BAXTER: You said "before" and "after."

MS. WEISS: I will try it again, then.

BY MS. WEISS: (Resuming)

Q If the circuitry were designed so that the operator could terminate emergency feedwater above the 95 percent level in the operating range, but he could not terminate it below the 95 percent level on the operating range, wouldn't that address your concern with overcooling? There would be no overcooling -- overfilling -- assuming the circuits work as designed?

A (WITNESS CLARK) I believe as you described it, it would prevent overfilling, provided it worked properly.

Q Right.

A (WITNESS CLARK) I do not believe it would address the question of dealing with a valve failure. I have to think through that sequence.

And example 4, what that talks about is a control valve malfunction. And the circuit you describe, I just would have to understand that circuit and think through any interaction with the valve before I would agree with that.

Q Okay. But it is your understanding that the company has committed to removing this independence between the integrated control system and the emergency feedwater, so that at least in the long term this particular single failure will not be possible.

A (WITNESS CLARK) I am not certain that that is committed to. Others here may be.

Q Well, assume with me that that is the case. Then that would address that concern, wouldn't it?

A (WITNESS CLARK) Would you say again? What is the case?

Q Assume it is the case that the company, your company, is committed to remove the dependence between the integrated control system and the emergency feedwater, so that that single failure mode is not --

A (WITNESS CLARK) The control valve malfunction --

Q Is no longer a possible failure mode.

A (WITNESS CLARK) I still don't understand exactly what circuit you have which would prevent overfilling. I suspect that what the company is separating is the electrical circuitry, and I do not know whether we are providing an additional valve. If we are not providing an additional valve, then the independence of the circuitry would not preclude a valve failure of the kind discussed.

Q But if they are providing that valve, it would preclude a failure/

A (WITNESS CLARK) I think in a general sense it would be possible to go provide additional circuitry or separation which would obviate this particular example.

CHAIRMAN SMITH: Ms. Weiss, certainly you are going to be permitted to cross-examine thoroughly on these examples, because they are part of the direct testimony. But haven't we come to the point in this contention where you have expressed what UCS's position is and the witnesses have expressed what the Licensee's position is?

It is the type of contention that is going to be very difficult to litigate on a finite number of examples.

MS. WEISS: Excuse me?

CHAIRMAN SMITH: I mean, we could add many more examples, perhaps, and still not ever litigate completely the contention.

MS. WEISS: I don't understand, Mr. Chairman

CHAIRMAN SMITH: Let's assume that you prevail in every one of these example. Have you really reached the contention?

MS. WEISS: Oh, yes. I think if they cannot find an example of a safety disadvantage associated with our proposal, then their speculations that there is such an example, they are speculations and they are not entitled to weight. There is a lot of other evidence on the subject. That is certainly not the whole ball of wax.

WITNESS CLARK: I would suggest that that does not result, that we would have a diametrically opposed position. And in particular, since as I understand it it is maintained by UCS that the three systems in question are illustrative only, and that the principle underlies all safety systems.

MS. WEISS: The contention is limited to the three systems stated.

WITNESS CLARK: Do I remember improperly reading a UCS position that once these three were determined, that you would move or some such term to have it applicable to all safety systems?

MS. WEISS: It is fairly irregular to have the witness interrogating the witness.

WITNESS CLARK: I am out of order. Excuse me.

CHAIRMAN SMITH: I did not think it was inappropriate. I introduced the idea of where we are on the different positions. I am not going to interfere any more. You certainly have a right to make a full record. I just wanted to tell you what the Board's problem was. Your position does go far beyond the examples, and as a matter of fact an essential part of the position is the unforeseen, the examples that they cannot come up with.

MS. WEISS: That is an extremely interesting point.

CHAIRMAN SMITH: Isn't it?

MS. WEISS: And I think we have crossed on that today. Part of it is in Mr. Pollard's testimony. He will be rebutting. But let me tell you what our position is. Babcock & Wilcox Company, in fact the entire nuclear industry, has spent thousands of man-hours of highly trained technical time trying to foresee all potential accidents and transients.

It seems to us they cannot have it both ways. They cannot come in here and say that, because of the unforeseen event to which they can attach no probability, that the operator is expected to be able to diagnose and correct that event.

CHAIRMAN SMITH: Your position is quite obvious.

I am just suggesting that there is only so much you can make on your examples.

MS. WEISS: We can at least establish -- and I think we can -- that none of them are examples that support the Licensee's position, until they come up with some other ones. We will shoot down the ones they have given us.

WITNESS CLARK: Could I say that I disagree.

MS. WEISS: Mr. Clark, your attorney will have an opportunity to voice disagreement.

MR. BAXTER: We also have a position that UCS has not established that all contingencies can be covered by design, and that is the other side of the coin.

CHAIRMAN SMITH: And you will notice that the Board sits here with studied indifference to all of the remarks. We do not know if you have or not.

MS. WEISS: You have not made your minds up yet. I am sure you are not indifferent.

CHAIRMAN SMITH: Right. When you say you supported, we take on blind expressions, moreso than normal.

(Laughter.)

MS. WEISS: If you could give mus, Mr. Chairman, about seven or eight minutes, I think we may be just about finished with this witness. But I would like to confer before I let them go.

CHAIRMAN SMITH: Do you mean a break of that long?

MS. WEISS: Yes.

CHAIRMAN SMITH: All right.

MR. BAXTER: Mr. Sholly has contentions?

MS. WEISS: Yes.

CHAIRMAN SMITH: Is that satisfactory? They are working together on it. It may be that Ms. Weiss --

MS. WEISS: I think we would like to talk to Mr. Sholly, too.

CHAIRMAN SMITH: All right. Take a break.

(Recess.)

BY MR. POLLARD: (Resuming)

Q Mr. Clark, assuming that our contention is limited, as the Board has limited it, to high pressure injection -- to emergency core cooling, containment isolation, and emergency feedwater, I would like to use the example of the Three Mile Island Unit 1 emergency core cooling systems, specifically determination criteria or the throttling criteria for high pressure injection as a base for my question.

Do you understand that?

A (WITNESS CLARK) Yes. If I understand it correctly, those are the criteria on Page 8 of the testimony.

Q Yes, sir. Now, as I understand your testimony, you testified that you thought if we took those signals and wired them into the circuit such that the operator could not terminate high pressure injection until one of those three conditions were met, that this would somehow interfere with the operator understanding what was happening in the plant.

Am I correct that that was your testimony

A (WITNESS CLARK) Yes, that was an element of it.

Q Okay. This very specific example, would you please explain how wiring those circuits, those signals into the high pressure injection circuits would interfere with the operator understanding what is going on in the plant?

A (WITNESS CLARK) I will attempt to. To really do it, you would have to design the interlock -- I mean, in order to do that, you would have to have in mind exactly what is the interlock, so I will try to suggest what might be involved in the interlock, and then, you know, if that is the way the interlock came out, suggest how it might confuse the operator. All right?

Q Fine.

A (WITNESS CLARK) There may be a better interlock, I guess, is what I am saying. In order to make the interlock fit those conditions, you would have to take in the case of a -- either two or four bow indications and a clock and a definition or something which would say when the condition started, and something which would in effect determine that the situation was stable.

Now, to do that last, it seems to me you would be dealing with primary coolant temperatures and pressures, perhaps, and again, with some sort of timer or rate of change, you know, change as a function of time. And so for Part A you would have to take those signals with the logic, and you would have to take the output of the logic, which determines that the criteria is met, and run it to some, I guess, auctioneering device relative to the other two criteria, B and C, and then run it to a device which would interfere with a signal from the operator to throttle each of the valves or to throttle the pumps. I guess you would need all of those elements.

Now, what I am saying is that if you had that situation, and you had a loss of coolant and the emergency core cooling system came into operation, you would still want the operator to see whether the systems were performing properly, so that if they were not performing properly, he could take action.

So, the operator would need some way to know what was happening in that system, for example, whether the defeat relay had failed or not. You would need a surveillance perhaps of that system to periodically determine that in fact it was operating properly or would operate properly when called upon. If I go from Part A down to Part B --

Q If you can answer the rest of the question without going through the circuitry for B and C, that is sufficient for my needs.

A (WITNESS CLARK) I can only do it in the general sense that both B and C would require taking additional signals, additional logic, and leading the output of the logic to the auctioneering device, and then the output of the auctioneering device to a relay, a switch, some device which would preclude the operator signal from getting through, and you would have to have either one common one of those or, for redundancy, more than one. And then you would have to face whether you would have the two for each piece of equipment, or whether you would have one pair which would serve for all pieces of equipment whose actuation you are trying to prevent.

So, in a general sense, I think that answers your question. Or not. I --

Q The part I am still missing is, how does that interfere with the operator understanding the condition of the plant?

A (WITNESS CLARK) If the -- If he determines that in fact ECCS is not operating properly -- all right. For example, he is looking at the flow meters. He has to consider not only the failures which the present plant configuration could cause but possible failures in this additional circuitry as to whether they could cause it.

In addition, when you start taking a signal, let's say an RTD signal, and leading it more than one place, there is always concern about being able to in fact completely isolate any feedback --

Q I would like to also -- Assuming everything works as it is supposed to.

A (WITNESS CLARK) I think that if everything worked as it is supposed to, then it is not a problem.

Q Okay.

A (WITNESS CLARK) The problem is that we do not assume that everything now in the plant works as it is supposed to. And equivalently, I think it would be improper to assume that everything we would add to the plant would work properly.

Q Yes, I understand. You would agree, however, that it might be possible to design an interlock which would in no way affect the starting of the system, but would only affect the ability of the operator to terminate the system.

A (WITNESS CLARK) I don't have a very detailed knowledge of that system, but I think, yes, what you say is so, or almost certainly so.

Q Now I would like to ask you a series of questions about a circuit which actually exists at Three Mile Island Unit 1. If you are unable to answer, perhaps Mr. Ross can assist you.

What is the normal operating pressure at Three Mile Island Unit 1?

A (WITNESS CLARK) I believe, depending on where you measure it, 2155.

Q And at what pressure does the high pressure injection system signal to turn on?

A (WITNESS CLARK) I will ask Mr. Ross.

A (WITNESS ROSS) The new set point will be 1600 psig.

Q As you take the plant from a normal operating condition to a cold shutdown condition, am I correct that the pressure would be reduced below 1600 pounds?

A (WITNESS ROSS) That is correct.

Q Therefore there must be some way to bypass this initiation signal. Is that correct?

A (WITNESS ROSS) That is correct.

Q Is there a limitation on what pressure above which the operator cannot bypass the high pressure injection signal?

A (WITNESS ROSS) There is.

Q What is that pressure, please?

A (WITNESS ROSS) That pressure would be approximately 1600 -- in this case, 1640 pounds.

Q Okay. Would you agree, then, Mr. Clark, that at Three Mile Island Unit 1 it is designed and will be designed at the time of restart such that the operator cannot bypass the initiation signal for high pressure injection above 1640 pounds?

A (WITNESS CLARK) You said initiating signal, and you are ight. That is the case. What you are discussing is the operating bypass we discussed earlier today.

Q I know what we are discussing, since I wrote the contention. So, then, you would agree that even for unforeseen circumstances, the operator would be unable to bypass the initiating signal for high pressure injection above 1640 pounds?

A (WITNESS CLARK) Yes.

MR. POLLARD: We have no further questions for these witnesses at this time.

CHAIRMAN SMITH: Mr. Sholly?

BY MR. SHOLLY:

Q Mr. Clark, I have a very few questions about your qualifications, and these relate mainly to specifics at TMI 1. Have you personally participted in establishing any procedures related to ECCS operation, containment isolation, or emergency feedwater system operation?

A (WITNESS CLARK) I have not participated in establishing. I have reviewed the procedures.

Q Which procedures have you reviewed?

A (WITNESS CLARK) To varying degrees, I believe, all three that you mentioned.

Q Have you reviewed the procedures to the extent that they provide for a bypass or override of those systems?

A (WITNESS CLARK) Certainly, in terms of the criteria which are in the testimony and which are extracted from the procedures, which I believe is what you are addressing. Yes, I have reviewed that.

Q Have you reviewed the training which the operators have received on the operation of these three systems?

A (WITNESS CLARK) Yes. In a general sense of the scope of the training, you know, how many hours, who gives it, and the question of what sorts of things are done at the simulator, which deals with some transients, and in the sense of what I consider a couple of key elements of the procedures, namely, the instruction to the operator to consider all of the indications available to him, and things of that kind.

So, I have reviewed those elements of the training program to assure that they are included.

Q Okay. At Page 3 of the testimony, at the top of the page, Mr. Clark and Mr. Ross jointly stated, "The ability for the operator to control a safety function following initiation serves to enhance safety."

Other than -- other than general beliefs or personally held opinions, which I think have been expressed earlier, are there any statistics or studies or records of any type which support your position that you know of?

A (WITNESS CLARK) Yes. I would be hard put to give you a reference, but there are studies that are reviewed in the Navy, studies of the question of further automating the plants.

There is experience. You referred to opinion, but it is based largely on experience. There is experience in my background of removing interlocks or automatic features from plants, because they were concluded to be detracting from safety.

Q I want to read you a set of conditions which I think will serve to scope that statement somewhat and see if you agree with them. Would you agree that that statement is true only under the following circumstances?

A (WITNESS CLARK) Do you mean by that statement the sentence in our testimony?

Q The sentence I read a few minutes ago. Would you agree that that is true only under the following circumstances, that the operators have correctly diagnosed the reason why the safety function was initiated? Would you agree that that would be true?

A (WITNESS CLARK) No. I do not believe that you can address this question in such discrete steps. What we are really addressing is, is it safer to have it this way than to have it that way, and therefore, to be able to answer the question, you would have to postulate an equivalent assumption for the automatic circuit, and so, I do not believe that it is possible to answer with regard to assumptions about operator behavior and say whether allowing him to operate enhances safety unless you are willing to at the same time postulate assumptions about circuit behavior.

Q For the purposes of this question, I am concerned mainly about the operator intervention, not -- I am assuming that when the operator calls upon a system, it is going to function properly, or when they intervene in a system, what they do in terms of calling on a piece of equipment, that that equipment is going to function properly.

Let me redo the entire set.

A (WITNESS CLARK) If I am to answer questions in that guise, I think the answers all have to be qualified by, you know, a statement to the effect, I think, that it is irrelevant, because what is being faced is a choice between whether you rely on an operator and you rely on a circuit, and to postulate going in that the circuit will always behave properly, and then discuss the possibility that the operator will not, is to prejudge the argument.

Q I am not in any sense trying to prejudge the argument. I am trying t explore the general subject of reliance upon operators, because it seems to be so heavily involved in your testimony and also responses to questions today. Let me read this entire set to you, and we will take it from there, rather than taking it an individual item at a time.

You have testified that the ability for the operator to control a safety function following initiation serves to enhance safety. Would you agree that that is true only under the following circumstances: A, that the operators have correctly diagnosed the reason why the safety function was initiated; B, that the operators refer to the correct procedure which governs operator control of the safety function; C, that operators correctly follow the procedure; and D, that the procedures themselves are technically accurate. In other words, they have correctly anticipated this scenario and provide operators with proper guidance to handle it.

Would you agree that that is the case, that that set of conditions must be met before operator intervention can serve to enhance safety?

A (WITNESS CLARK) I do not agree, because as read they implicitly assume that the circuit will perform correctly. In addition, they assume that in all cases the operator needs to refer to a procedure, and thereby excludes the unforeseen events for which a procedure would not exist, and perhaps if I had a little more time, you know, there may be some other qualifications I wish to put on that.

Q Would you agree that if an operator prematurely bypasses or overrides a safety function, that that can serve to degrade safety rather than enhance it?

A (WITNESS CLARK) Yes, I would agree that that would be possible.

Q So in other words if an operator finds itself in a particular situation where a safety function has been automatically initiated, and they take a look at the readings on their instruments, and determine that they are satisfied that conditions are met for bypassing this system, do you agree that if they are mistaken in that judgment, that this can degrade safety, in other words, that they can prematurely --

A (WITNESS CLARK) Regardless of the reason why, if the operator takes an improper action with regard to a safety function, it is possible for him to degrade safety.

Q If you refer to Page 5 of the testimony, and this continues on to Page 6, you discuss criteria for selecting particular actions which you would see as needing automatic control versus actions that would need operator control. You make the point that subsequent bypass of automatic initiating circuits proceeds in a much more deliberate basis, and the operators have ample opportunity to verify that conditions prerequisite to bypass are in fact met.

Talking specifically now about the emergency core cooling system, is there any minimum time period during which ECCS should not be bypassed following initiation?

A (WITNESS CLARK) I don't think that is the sort of thing on which you can put an absolute limit. For example, let us suppose that you had an inadvertent actuation of ECCS and every indication available to the operator showed that there was no loss of coolant. In fact, he had indication and somebody happened to be standing beside the instrument which initiated the signal and informs the control room that there is a fire in the widget. I would think that however fast that happened, the operator would be warranted in throttling or bypassing or taking whatever action, because in the case of postulated, he clearly knows by then that it is okay.

There are rules of thumb which people have used, and, you know, some people use a rule of thumb of several minutes and others use longer. It depends on the plant and, you know, which safety system, et cetera. So I would not want to suggest an absolute limit.

Q Let me qualify the question a little bit and see if this helps you at all. What I am concerned about is that there are finite number of things an operator must do following the initiation of HPI, for instance. There are certain parameters that the operator must check according to the procedure on Page 8 of the testimony before HPI can be terminated or throttled.

Has there been any determination made of how long that takes? The operator is concentrating on verifying that the conditions are met so that he can throttle or terminate. How much time passes between initiation and when the operator can reasonably be expected to reach that determination?

A (WITNESS CLARK) I think Mr. Ross is perhaps better able to respond to that than I, that strict clarification. Is the question after the condition is reached which would meet the criteria how long does it take the operator to make that determination?

Q Once the safety function is initiated, HPI comes on for whatever reason. How long does it take from that point once the operator realizes that HPI is on. You are going to be looking at some point to either throttling or terminating HPI once conditions appropriate are met. How long physically, how long does it take to go through the processes to examine the instruments, examine whatever else the operator is going to take a look at to reach that conclusion that in fact conditions have been met that he can throttle or terminate?

A (WITNESS CLARK) I think you need to think about two time elements. One is how long before the conditions would in fact reach the point, and that, of course, depends on, you know, how severe is the accident and a variety of other things. So, there is some time increment after the accident before the conditions in fact are satisfied, and then there is an additional increment of time for the operatoa to satisfy himself that they are met.

Is your question aimed -- the first one is a variable depending on the accident. Is your question aimed at the second, that once all the temperature -- once you have 50 degrees saturation margin, how long would it take the operator to go read all the instruments and satisfy himself that you have it?

Q Let me move on to something related, and we will come back to that. I think it will help illustrate what I am driving at.

The other day, there were, I think, two staff witnesses on, and I questioned Mr. Martin, and this is beginning at Page 5441 of the transcript --

A (WITNESS CLARK) I do not have a copy of that transcript.

Q In brief, we were discussing the sequence of events during the accident referring to NUREG-0600. The date is November 12.

A (WITNESS CLARK) It is possible I do not need it in front of me if you want to ask the question, but I don't have it at this point.

Q In the sequence of events, there were a number of instances where safety features were actuated and very rapidly bypassed, and in questioning Mr. Martin we were able to establish that in fact there were two instances, and you may want to refer to NUREG-0600 to answer this, but there were two instances.

In one case, the operator bypassed the reactor building isolation and safeguards initiation 13 seconds after it occurred, and in another instance I believe it was

18 seconds.

A (WITNESS CLARK) I remember looking at the sequence, and you know, I presume you are reading them out right, but it was seconds. Less than a minute passed between actuation and bypassing of some of the things during the accident.

Q Those are the instances which lead me to my concern about how long it takes for the operator -- Is there an alarm that signals to the operator that HPI has been initiated?

A (WITNESS CLARK) Yes. I would say.

A (WITNESS ROSS) Yes, there are a number of alarms that will signal that it has been initiated.

Q So the operator would know that HPI is on?

A (WITNESS ROSS) Not only from alarms, from changes in plant conditions and their resulting alarms.

Q Okay. Now, once the operator realizes that HPI is on, he is going to want to find out why. Presumably, that will take a certain amount of time.

A (WITNESS ROSS) That is correct.

Q Would you agree with that?

A (WITNESS ROSS) Yes, sir.

Q It will also take a certain amount of time, then, I presume, for the operator to examine the instruments which are necessary to determine whether or not the operator can throttle or terminate HPI. That is also correct, is it not?

A (WITNESS ROSS) That is correct. I might point out the example you gave, the Unit 2 accident, that throttling criteria did not exist then, so you should not compare the two.

Q I realize that. What I am trying to get at is how long might this reasonably be expected to take? In other words, let me ask you a very direct question. Do you feel it was appropriate for the operator to have bypassed those systems in 13 or 18 seconds?

A (WITNESS ROSS) That is a judgment call on my part. Under the guidelines that existed at that time, there would be nothing that would really prohibit him from doing that. He thought he had an inadvertent actuation. There was no defined throttling criteria.

Q Given the criteria that the operator is presented with now, would it be conceivable that an operator could bypass that HPI within 13 or 18 seconds?

A (WITNESS ROSS) I think it would be safe to say it would take some time longer, depending on the plant conditions that you started from. That time would vary.

Q Getting back to the original question, is there some minimum time during which the operator could not possibly know why HPI came on, he could not possibly know whether the conditions are met to enable him to throttle or terminate. Is there a certain amount of time there, I would assume, that it is physically impossible for the operator to figure out why he is in the condition he is in, and whether or not he can throttle or terminate HPI?

Have you any judgment as to how long that time period is?

A (WITNESS ROSS) I do have a judgment. That is just what it would be. It would vary on, as Mr. Clark pointed out, a known inadvertent actuation. You would at that point look up and see that you are subcooled. You would also look up and see a rising pressurizer level. You would bypass it. That would be a matter of seconds.

Another condition, nobody knows why. It is initated and pressure is decreasing. That would take somewhat longer to justify bypassing.

A (WITNESS CLARK) I think it is also fair to say that with the emphasis that was and is and will continue to be in the training program, that there is going to be a tendency for the operators to be very, very sure before they bypass an emergency system, and would only move quickly in the event they felt they were approaching another situation which would involve some safety implication such as driving the plant solid or driving it out to the safety valves, or something like that.

I do not think any operator training program or event that I can foresee would do anything but cause these people to be considerably more hesitant about how promptly they respond to that kind of thing.

Q Would you foresee any safety disadvantage in a system, be it an interlock or whatever, that would prevent an operator from bypassing a safety system once it is initiated for a certain period of time, in other words, to ensure that the operator goes about determining whether he can bypass or throttle HPI, for instance, in a considered manner, in other words, that would not permit him to do it in 13 seconds or 18 seconds, but would require him -- phyiscally give him enough time to check the procedures or check the instruments.

Do you foresee any disadvantage to that?

A (WITNESS CLARK) Yes, I do. It is, you know, the general disadvantage we have discussed. I think the amount of the disadvantage is, you know, in a sense related to how complex the system is that you add. And as you reduce that complexity, then you know the possibility of overlooking something or finding it interferes with something you need to do happens less.

But I think the underlying criteria in my judgment is that you only provide those automatic things which are required because you do not believe you can rely on the operator, and I do not believe that such a thing is required, and therefore my judgment is that there would be a net disadvantage to providing it.

Q In other words, you would rely on the operator's training and knowledge of procedures to prevent him from prematurely terminating a safety function?

A (WITNESS CLARK) Yes. I think there is also an element of this that perhaps has not come out. Once you get through the very quick response time of an automatic trip and things where we would all agree you should have automatic action, you cannot rely on the operator. If an operator does turn something off or throttle it or change it, it is by and large, and I think almost without exception, not irreversible.

So, if he did go too quickly, he can turn it back on again. And you know, I think we should not lose site of that fact, that operator actions are not irreversible in the sense an interlock is. If you set it up so you cannot do something, you cannot do it.

Q Would you not also agree that if the operator prematurely terminates a safety function, that it is not inconceivable, and I think TMI 2 accident is an example of where conditions become confusing to the point where it is a self-reinforcing condition where the operator continues to believe that he has done the correct thing in throttling or terminating HPI and continues to do that in defiance of actual plant conditions.

A (WITNESS CLARK) I think the fact that the operator terminated something prematurely is less likely to confuse the situation than if there were a system which prevented him from acting. And I believe in the case of the TMI 2 accident, the operators terminating some of the safety systems was not the cause of the confusion.

The cause of the confusion was the prior training, which did not allow him or biased him against properly determiningnthat accident and had him focused on keeping the pressurizer from going solid, and I think it was that training and background which caused the confusion.

CHAIRMAN SMITH: Mr. Sholly, we have gone beyond our normal adjourning time. We will abide by your pleasure. If you would like to break and take it up tomorrow, we will. If you think you can reasonably finish tonight, we will do whatever you wish.

MR. SHOLLY: I think I perhaps have another half hour or 40 minutes.

CHAIRMAN SMITH: All right. We will break and resume in the morning.

MR. SHOLLY: Fine with me.

CHAIRMAN SMITH: Tomorrow -- Let's adjourn until -- Let's discuss what we have to do tomorrow. Will we try to accomplish anything more than this panel tomorrow?

MR. BAXTER: I would hope so.

CHAIRMAN SMITH: So we will get to staff's panel.

MR. BAXTER: Mr. Pollard would be next.

CHAIRMAN SMITH: Would there be any advantage in starting at 8:30 tomorrow? We can go to 12:30.

MS. WEISS: I think it is outweighed by the disadvantages.

MR. POLLARD: I have commitments that will prevent me from being here.

MR. BAXTER: What time would your commitments require you leaving?

MR. SHOLLY: Twelve-fifteen.

(Whereupon, the Board conferred.)

CHAIRMAN SMITH: Eight-thirty. We will meet tomorrow at 8:30.

(Whereupon, at 5:22 p. m., the Board was recessed, to reconvene at 8:30 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 (Three Mile Island Unit 1)

Date of Proceeding: November 20, 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)

Alfred H Ward

Official Reporter (Signature)