T-1147

NUCLEAR REGULATORY COMMISSION

ORIGINAL

In the Matter of: ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC ASSESSMENT

DATE: November 3, 1982 PAGES: 1 - 231

AT: Washington, D. C.

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400 Virginia Ave., S.W. Washington, D. C. 20024

Telephone: (202) 554-2345

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFGUARDS

SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC ASSESSMENT

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Nuclear Regulatory Commission

1717 H Street, N.W.

Washington, D.C.

Wednesday, November 3, 1982

The meeting of the Subcommittee on Reliability and Probabilistic Assessment of the Advisory Committee on Reactor Safeguards was convened at 9:00 a.m.

PRESENT FOR THE ACRS:

WILLIAM KERR, Chairman

DAVID OKRENT, Member

DAVID WARD, Member

MYER BENDER, Member

JESSE C. EBERSOLE, Member

J. CARSON MARK, Member

CHESTER P. SIESS, Member

DESIGNATED FEDERAL EMPLOYEE:

R. SAVIO

ACRS CONSULTANTS:

P. DAVIS

E. EPLER

D. POWER

M. TRIFUNAC

D. PEDERSEN

J. MARCHATERRE

C. MUELLER

R. SEIDENSTICKER

ALSO PRESENT:

A. THADANI

E. CHELLIAH

S. ISRAEL

T. PRATT

I. PAPAZOGLOU

S. VARGA

MR. KAUFMANN

S. ACHARYA

A. SCHWENCER

MR. MEYER

P R O C E E D I N G S

MR. KERR: The meeting will come to order.

This is a meeting of the Advisory committee on Reactor Safeguards Subcommittee on Reliability and Probabilistic Assessment.

My name is William Kerr. The other ACRS members present at this point are Mr. Okrent, Mr. Bender, and Mr. Ebersole. The consultants here present for the Committee are Messrs. Davis, Epler, Power, Pedersen, Marchaterre, Mueller, and Seidensticker.

Mr. Richard Savio is the Designated Federal Employee for the meeting, which is being conducted in accordance with the provisions of the Federal Advisory Committee Act and the Government in the Sunshine Act.

Rules for participation in today's meeting have been announced as part of the notice of the meeting published in the Federal Register on Thursday, October 21, 1982. A transcript of the meeting is being kept, and will be available by November 5, 1982.

I request that each speaker identify himself and use a microphone.

We have received -- there is a "no" missing, I think. Mr. Savio, the Designated Federal Employee, there should be a "no" in here? We have received no written requests for time to make oral statements.

We will proceed with the meeting, and I call upon Mr. Thadani to orchestrate that part. That will be the NRC staff presentation. Mr. Thadani.

MR. THADANI: My name is Ashok Thadani, NRR staff. With me today are some members of staff as well as consultants who have been supporting us in our reviews that we have performed to date.

Before we get into summarizing the results of our review of the Indian Point and Limerick risk assessments, I would like to just take a few minutes to give you some background on the motivation for performing these studies.

MR. KERR: Excuse me. Is that mike on? It is? Maybe you or it should get closer.

MR. THADANI: Is that better?

MR. KERR: I think so.

MR. THADANI: Following the TMI 2 accident, the Commission deemed it necessary to reassess the safety of all nuclear power plants with some special emphasis on high population density sites, such as Indian Point and Limerick. During the last two years, several key events have taken place. I will list some of them.

The Union of Concerned Scientists petitioned to shut down Indian Point units. The NRR director

ordered implementation of interim measures which would improve the safety of the plants, and studies are under way to determine whether any additional actions would be necessary. The Commission decided that the operation of Indian Point units should not be suspended, but recommended that proceedings be initiated to primarily determine how the population around these sites would impact risk as compared to risks at other sites.

With this sort of a background regarding the concern with high population density sites, the licensees for Indian Point Units 2 and 3 and the Limerick applicants submitted PRA's for their plants. Along with their PRA's, they identified some modifications which they believed would improve the safety of these plants.

We have been reviewing these studies now for the past several months. The objective of our review is pretty similar in terms of both Limerick and Indian Point. There is a key difference. As far as the Indian Point review is concerned, the emphasis really is on reviewing the study and assisting us in the preparation of our testimony regarding the Indian Point facilities as it might compare with other sites, and in particular to assess the impact of proposed improvements which include the NRR director's order regarding interim

measures regarding how this would impact risk.

In terms of Limerick, about two years ago the applicant was asked to perform a PRA by the NRC. The concern again was the population around the site, and the hope that if we were to go ahead and do a PRA early enough, we might learn something from it and determine if any actions might be needed in view of the high population density around the site.

We have basically been assisted in the reviews of these PRA's by two major labs with some other subcontractors. Sandia has been assisting us in terms of the review of Indian Point's risk study, in particular that portion of the study that relates to core damage accident sequences and their quantification. Brookhaven National Lab has been primarily supporting us in terms of the containment analysis work.

In terms of Limerick, Brookhaven has been reviewing and supporting us in all aspects of the PRA.

Our assessment of the core damage accident sequences and their quantification -- when I say our, I am referring to the Sandia assessment -- it is essentially complete. Our testimony is still under preparation for Indian Point. In terms of Limerick, the preliminary analysis is complete. We just received a

draft report from BNL. BNL expects to complete its review in about three months. The staff will complete its review and evaluation by the summer of next year.

Today, we are ready to give you some summary results of the assessments done so far. We will begin with Indian Point and then move on to Limerick, if that is acceptable to you. We could certainly switch it around. Let me introduce Sam Israel, who will give us his assessment of the Indian Point study.

MR. ISRAEL: Good morning. I guess I will apologize. The first two pages on the handout are in reverse order. I am also presuming that the Committee and the consultants have seen the Sandia draft letter report on Indian Point, the review of the Indian Point study, the assumptions I am going to make.

(Slide.)

MR. ISRAEL: We requested Sandia to review the Indian Point probabilistic safety study. They had about three months to do this. Basically, their review consisted of reading the IPPSS study and also bringing to the review whatever experience Sandia personnel had from previous PRA's. They did not do any de novo review of the plant itself. So basically the information was reviewing the IPPSS study and their own knowledge and background.

My first slide deals with core melt frequencies for both Units 2 and 3. Basically, my talk will deal mostly with numbers. Sandia in its charter was requested to revise or come up with their best estimate of what the core melt frequencies were at the units based on the review of the IPPSS study. I have up here a table showing Units 2 and 3, the IPPSS value for core melt frequencies, and the Sandia values.

MR. KERR: Excuse me. Is that what "revised" means?

MR. ISRAEL: That's correct. Those are Sandia's numbers. These numbers are as of September of this year. These numbers were recorded in their report, their draft letter report.

MR. KERR: Does revised imply that these have now been discussed with the people who did the Indian Point study, and there is general agreement that they are more valid than the earlier ones, or does revised simply mean these are the results reached by Sandia?

MR. ISRAEL: These were results obtained by Sandia. They issued the report roughly September 1st. The staff and the licensee had about one month to review the Sandia report, and made comments on the report. We had a meeting with the staff and the licensee in Sandia in October, about two weeks ago, and now Sandia is in

the process of assimilating whatever that give and take was in that October meeting and the information received from various memos. They may or may not revise these numbers that I have up here. They are scheduled to provide a final report by December 15th.

So, these numbers I have here are the numbers based on Sandia's initial review, some interaction obviously with the licensee, interaction being getting the information and bargaining, so to speak, with the licensee as to whether these numbers seemed more appropriate or not. These are as of September 31st, and they could very well change, and in fact they will change, and I will explain that later on in my talk.

Roughly, the internal for Indian Point 2 they have increased by about a factor of two here. On Indian Point 3 it is about a factor of two, about a factor of four on the external, a factor of four. Overall it's a factor of three increase in the estimated core melt frequencies on both Unit 2 and Unit 3.

MR. DAVIS: Excuse me. A question.

MR. ISRAEL: Yes.

MR. DAVIS: In the review by Sandia, did they look both for factors that would tend to decrease the core melt probability as well as increase it? That may sound like a trivial question, but it seems to me

that --

MR. ISRAEL: As a matter of fact, in my next slide you will see they have increased the frequencies. Whether they made a special point of looking for these, I can't say.

MR. DAVIS: I found several conservatisms in the study that would tend to decrease the result by the applicant, and I am curious as to whether those things were pursued in its review. Maybe we will find out.

MR. ISRAEL: We will find out.

(Slide.)

MR. ISRAEL: What I have tried to do here in an overall vu-graph is to indicate what the dominant types of events were that proposed the core melt frequencies that were shown in the last slide. Roughly, this is greater than 80 percent of the core melt frequency. This is the IPPSS study. This is Sandia (indicating). Seismic, fire, hurricane, tornado, LOCA, recirc, station blackout. An additional one that Sandia has picked up is component cooling water pipe break, which I will discuss later on.

These comprise better than 80 percent of the core melt frequency. For Unit 3, fire and LOCA during recirc were the dominant sequences. Sandia also agreed to those dominant sequences. They also picked up

component cooling water pipe break as a significant contributor to core melt.

MR. BENDER: Are these in the order of significance?

MR. ISRAEL: No, I just put them down.

MR. BENDER: Okay.

MR. ISRAEL: I guess the point I should make is, there are a large number of external events indicated in the dominant sequences.

MR. KERR: What is meant by partial station blackout?

MR. ISRAEL: If you have a station blackout, you lose off-site, you also lose on-site AC. You cover off-site power some time into the event after core melt.

MR. KERR: It is a short term station blackout?

MR. ISRAEL: Yes, as opposed to -- well, I have used this nomenclature. If you had a full station blackout that extended for a long period of time, this obviously gives you core melt. It also makes you vulnerable.

MR. KERR: I was trying to understand how you could have anything other than a full station blackout, because station blackout to me means loss of power.

MR. ISRAEL: As I say, this is recovered some time into the event.

MR. KERR: Partial means short-term.

MR. ISRAEL: Yes.

MR. BENDER: Sandy, one other question while you have that up there. If I look just at the seismic question, is the reason why it is dominant because the anticipated probability of certain seismic events is such that the higher events have not been designed for, or what?

MR. ISRAEL: Yes, but let me get to that.

MR. BENDER: All right.

MR. ISRAEL: I just wanted to give you an overview as to what the dominant sequences are. I have made a point of not using alphabet soup so you can all understand.

MR. BENDER: You get an A+ for that.

(Slide.)

MR. ISRAEL: I am going to go through the units in order. I will go through Unit 2, and then Unit 3. This is Unit 2. This is for events that have containment failure prior to core melt. I am going to apologize. Indian Point has an interfacing LOCA at about $5 \times 10^{-7}$. This is about an order of magnitude less than what is in WASH 1400 for Surrey, the reason

being that you have extensive intengrity checking of the check valves, et cetera, in the interfacing lines.

This number has been revised somewhat after interactior between Sandia and the licensee. They have improved the data base. They have changed the modeling a little bit. The number is still fundamentally the same. Sandia has also identified another event that would fall into this category. This is a steam generator tube rupture with a stuck open secondary safety valve. This is an outgrowth of the Ginna event that happened roughly about a year ago, where the operators continued to pump in high pressure injection, and they filled up the secondary line and opened up the safety valve, and there is always the potential for that sticking open.

The core melt sequence here is that you have a stuck open safety valve. Now you have a path outside, and you just keep pumping in water from the refueling water storage tank. That will take a good deal of time, somewhere between 12 or 24 hours, before you run out of refueling storage water. So that this then reflects core melt frequency such that the operators have caught on and somehow isolated the event or depressurized the plant down to below 212 degrees, to that you are no longer losing inventory and have RHR.

MR. BENDER: The result causes loss of inventory water? You eventually run out of water? Is that the idea?

MR. ISRAEL: That's right. That's right. It will take a long time, somewhere between 12 and 24 hours. There should be another event on here, and that would be a seismic event that takes out containment on Unit 2. The frequency of that was somewhere around $6 \times 10^{-7}$. The revised estimate by Sandia would be something like $10^{-7}$. That event is an earthquake that is larger than the safe shutdown earthquake, probably up around one G. And there is a -- the earth is packed in against the containment on Unit 2. I am talking about backfill at this level earthquake interfering and disrupting the containment, therefore losing cooling and ultimate core melt.

MR. OKRENT: Question. Is the revised estimate $10^{-7}$ or $10^{-6}$ for Sandia?

MR. ISRAEL: $10^{-6}$. I am sorry.

MR. OKRENT: Another question. In its comments on Zion, which was not unlike Indian Point, Sandia noted that one could arrive at very large uncertainties several orders of magnitude on interfacing systems LOCA. What is not clear to me is how Sandia arrived at its number, in view of its comment about the

large uncertainties that exist and how one might interpret the available data. Did it occur to you?

MR. ISRAEL: Let me address that.

MR. OKRENT: I read what is in the letter report. I agree you can follow a recipe and get a number. That's not my question.

MR. ISRAEL: I understand. When we are here on Zion, the information basically we are using was the information coming from WASH-1400. Interaction with PLG basicall back in June said we have this open-ended situation. They went back and they interpreted available information. This interpretation dealt with a logical inference about check valves and the fact that if the check valves were leaking or had failed, that would be noted by some other perturbation in the system.

I cannot give you what this logic was, but using that, they were able to go back and go over the available history and come up with new numbers for the leak failure rate, or not the leak failure rate, the rupture failure rate of the check valves, which was an important ingredient.

Having data like that also allowed them to have much tighter uncertainties on that type of information. That was for the check valves. The other

important ingredient was the suction line, which has two motor operated gate valves. The sequence there that we are concerned about is that the operator failed to close one of the gate valves, and they were sitting there on one of the other gate valves and that ruptured.

The key to it was the probability of having a gate valve, one of those gate valves left in an open position. That could only occur -- the position indication was downstream of the system. Iff the motor had engaged from the valve stem, then you could potentially get an erroneous position indication. PLG went back and they looked through the available literature on the number of times the gear linkage between the motor and the valve stem had become disengaged, and they were able to come up with a better estimate as to what the initial probability of having an erroneous indication would be, so they came up with tighter uncertainty bounds, and that made that problem go away.

As you recall, the problem with zion was, what is the uncertainty on something that basically has not happened? For most of what the licensees have done on Zion, they had taken WASH-1400 and made it 20, 80, or whatever the bounds were, as opposed to 595, which was in WASH-1400, except for this valve situation.

Obviously, that gives you tremendously different numbers. However, you are still guessing at what the upper bound is on the situation. Nobody ever arrived at what the correct number bound was for that. We finessed this. We finessed this by going back and developing better data and coming up with tighter estimates.

MR. KERR: Now I am confused. I thought you were asking how Sandia arrived at uncertainty estimates. Did I misunderstand your question?

MR. ISRAEL: Sandia didn't arrive at uncertainty estimates. The question was, the uncertainty as large as discussed on Zion. The answer is no, because at least in this revised estimate, which was really an interaction with the licensee, the licensee has come up with tigheter estimates of what the failure probabilities are for the check valves, and also for leaving the gate valve open.

MR. OKRENT: He has answered the question, but I'm not sure whether we have available a critique of the new method. They have gone at getting data, more detailed data, a different way on specific failure modes, and there was very little information on that in the letter report.

MR. EBERSOLE: Can I ask a question? Sandy, do these studies account for the fact that you never

know whether these check valves are in proper closed position or not?

MR. ISRAEL: Yes. Which studies are we talking about?

MR. EBERSOLE: These studies themselves.

MR. ISRAEL: These reflect that the check valves are leak tested after they are disturbed.

MR. EBERSOLE: No, I mean they are stuck flat open and that leaves you vulnerable to a spurious opening, to the only other opening of the low pressure system, the motor valve. You don't have indicators as to where the valve disc is at all.

MR. ISRAEL: I go down, I am called to do my refueling, I go back up. When I go back up, I leak test the check valves so I know they are in position. I know I have integrity.

MR. EBERSOLE: Every time you upset them, you do that?

MR. ISRAEL: That's right. Every time I go back up I am testing these valves.

MR. EBERSOLE: So you ascertain that they are bounded by the leak test, and in fact they have not been upset.

MR. ISRAEL: That's right.

MR. OKRENT: That is something that actually

is done, or is something that will be done? And if it is done, how long has it been done -- I am just sort of curious -- for these plants?

MR. ISRAEL: That was required by the Denton order of '81, I guess. I cannot tell you how many times it was done over the past year and a half. Both plants are down now, so when they go back up, they will go back into that mode.

(Slide.)

MR. OKRENT: To some extent, I think it is of interest, although not something that we can try to answer today, for the NRC not only to get an evaluation of what they think the risk will be, given certain things that are promised will be done, but what it was even prior to TMI 2. Let me just leave that as a thought. How much change has occurred, if any, and due to what? Okay.

MR. ISRAEL: Okay, on this slide here, I have core melt with no containment cooling. I have tried to put these slides in order of reduced potential risk. Obviously, containment failure prior to core melt gives me potentially the highest significant risk. I have core melt with no containment cooling. This obviously gives me potential problems with risk situations. These revised again are Sandia September 1st seismic.

For Unit 2, the seismic event was the Unit 1 control building or superheater building banging into the roof of Unit 2 control building, failing the roof, incapacitating the operators in the control room, thus going to core melt because there is no one minding the shop. That occurred at a medium capacity at about .26, and these plants safe shutdown earthquake was about .15, something like that.

Sandia's consultant was the same chap who reviewed Zion, John Reid, or Pat Benjamin Associates, anyway. He looked at the seismic portion and you can see the core melt frequency has increased by a factor of two. The reason for this is, there were two different hazards curves presented in the IPPSS study performed by the consultants for the licensee at the point of sustained peak acceleration. One of the studies was about an order of magnitude lower than the other study. The licensee simply weighted both the same and divided them by two and came up with whatever their hazard curve was, whereas Sandia's consultants said they were somewhat skeptical about the hazards curve. It was an order of magnitude lower than the other one, so they discounted that completely, so there was no averaging, thus the difference of two core melt frequency.

MR. KERR: Why were they skeptical of the

lower one?

MR. ISRAEL: I cannot answer that. Buck, can you?

MR. ABRAHAM: Buck Abraham, NRR, Geosciences Branch. The magnitude or the intensity used in the study was a little bit low, and the zonation signal for the tectonic province will not be completely represented for the area around Indian Point. They used an intensity of seven, and we used the deterministic method. We think that intensity seven was low for the area. The values estimated was around an order of magnitude less.

MR. KERR: You have told me that you think the intensity of one is less than the other, and I still do not know how one decided which is a more nearly valid result. The staff's judgment is that it should be eight rather than seven?

MR. ABRAHAM: That's true.

MR. KERR: Sandia apparently researched that conclusion independently.

MR. ABRAHAM: Yes, and the intensity is more representative of this area.

MR. ISRAEL: Fire (indicating). The fires that I have here basically are fires that take out cooling to the reactor coolant pump seals which then

fail. They take out the high pressure injection pumps and the ECCS pumps so that you cannot provide cooling after you have this LOCA, and no containment cooling, so therefore I've taken out the service water pumps or the fan coolers or the component cooling water pumps, and I have left myself pretty high and dry with this event.

MR. KERR: How would that number compare with one that one would have used prior to the NRC's fire protection limit in 10 CFR 50?

MR. ISRAEL: This represents -- since I don't think the licensee has made any modifications with respect to Appendix R yet, this represents what it would look like without Appendix R modifications.

MR. KERR: Is the licensee required to make --

MR. ISRAEL: Yes, I will try to touch on that. The licensee's analysis was based on a general area fire in tunnels and switchgear rooms and whatever have you that takes out all this electrical equipment. Sandia, based on its experience in the fire area, was concerned about a hot gas layer, a layer such that if you have a fire any place the gases formed go to the ceiling, and that the cabling through their experience would fail at temperatures lower than the ignition temperature of the cabling itself.

Therefore, this would essentially enlarge the

area, the fire area that would catch the essential electrical equipment, and that has increased by a factor of three.

MR. KERR: The insulation would melt rather than ignite?

MR. ISRAEL: That's right, would short out. That's my understanding.

MR. KERR: Insulation doesn't short out. I was concerned about what would happen to the insulation before it ignited.

MR. EBERSOLE: You mean not that it softens and the conductors merge? Is that right?

MR. ISRAEL: I don't have any fire people here. There were tests run at Sandia dealing with certain cabling --

MR. EBERSOLE: You can melt the insulation before you burn it.

MR. ISRAEL: -- that resulted in shorting out of the cabling at temperatures lower than the ignition temperature of the cabling, but that exact mechanism I can't tell you about.

MR. EBERSOLE: Does that also mean other provisions in Appendix R haven't been put in at this point?

MR. ISRAEL: As I said, this doesn't reflect

Appendix R. The licensee for Unit 2 has proposed modifications approximately a month ago that will undoubtedly reduce these core melt frequencies.

MR. KERR: Is there any estimate of how much of a reduction will be produced by Appendix R?

MR. ISRAEL: The licensee has estimated that it would go down, let's see, by about a factor of 20, I believe.

MR. KERR: Twenty?

MR. ISRAEL: Right.

MR. BENDER: What are we starting from, Sandy? What is the fire frequency that exists, and how much are we improving it by Appendix R?

MR. ISRAEL: The fire frequency is whatever it is. You have these general -- they are talking about potential for general fire in the tunnel in the switch gear room.

MR. BENDER: The probability of one?

MR. ISRAEL: Improvements are such that you bypass the electrical tunnel, the switch gear room, and these general fire prone areas entirely, and you now provide electrical equipment to essential equipment. The fire frequency in these areas hasn't changed. It just bypasses it.

MR. BENDER: If you are talking about an

improvement of $10^{-4}$ to ten to the minus something or other, you start first with some probability of a fire, then some probability that the fire will damage it in this location, and the damage will be to such a degree that it leads to core melt. That is the logic. I was trying to put the things together, and I guess I don't know where they're put together. Where are they put together?

MR. ISRAEL: Right in here. You have the frequency of the fire, the conditional probability that the fire was large enough that it envelopes the essential equipment.

MR. BENDER: I just asked what was the frequency of the fire. I know you don't know, and I just wonder where would I find it if I wanted to know it.

MR. ISRAEL: That would be in Chapter 7 in the IPPSS report, 2073, something like that.

MR. OKRENT: The Appendix R provisions minimize or preclude the possibility of this hot gas streaming effect?

MR. ISRAEL: I don't think Appendix R addresses the mechanism for the fire.

MR. OKRENT: This is not a mechanism for the fire.

MR. ISRAEL: I meant the mechanism for failing the equipment. Appendix R says thou shalt have a fire and it takes out essential equipment, provide me an alternate scheme.

MR. OKRENT: But it has certain separation requirements. I was just wondering whether they included this phenomenon.

MR. ISRAEL: I'm afraid I cannot answer that, Dr. Okrent. I don't see anybody here from the staff who would be familiar with that.

MR. BENDER: Well, in the sense that they don't identify the probability that the barriers are going to be violated so that you get hot gas streaming, they don't pay any attention to them. There may be some implicit reliability in the barriers that isn't stated.

MR. EBERSOLE: Sandy, was there in this study a consideration of a fire in the spreading room and the control room?

MR. ISRAEL: Yes, in the spreading room, the tunnel, the licensee's response about a fire in the control room was that that would be a fire that would affect enough equipment with no core containment cooling. The frequency of that would be less than this frequency. That was a judgment.

MR. EBERSOLE: Does this plant have an

auxiliary shutdown room that anticipates a disruption of the control room?

MR. ISRAEL: Yes. I guess I wouldn't call it a single auxiliary shutdown. They have panels at various locations in the auxiliary building.

MR. EBERSOLE: Are they backwired into the control room circuit boards?

MR. ISRAEL: I don't know.

MR. EBERSOLE: That's the critical thing. Old GDC 19 let them do that. They did that because they were allowed to. It produces an invalid concept of protection.

MR. ISRAEL: I would presume -- this is a wild presumption on my part -- that the people who are looking at Appendix R are concerned about the ability to operate the equipment.

MR. EBERSOLE: Can anybody here answer whether or not the plant can be shut down in the absence of functional capability out of the control room?

(No response.)

MR. KERR: I see no volunteers. Please continue.

MR. ISRAEL: Hurricane. Unit 2 has metal sheathed buldings for the diesel generator and for the control room. The licensee had estimated a core melt

frequency with no containment cooling of about $3 \times 10^{-5}$. That is basically you lose off-site power. You also take out your diesel generator, because of the metal sheathed building, and that would give you that kind of core melt frequency.

Sandia's consultants analyzed it and said, no, it is higher, about a factor of 20 higher. Two of that is due to the fact that the Sandia consultant believed that for hurricanes of any magnitude, you were going to lose off-site power, so there's a factor of two associated with off-site power. The Sandia consultant also had a more recent NBS hurricane hazards curve that would indicate a much higher frequency of winds. I think it is 200 kilometers in from the coast, whatever it is, so they have re-estimated the hurricane as being 20 times higher than the Indian Point estimate.

Tornado, there was no difference, the analysis being acceptable.

MR. BENDER: Where would an ice storm fit into that same scenario? We have had icing conditions that have knocked out off-site power as well.

MR. ISRAEL: That's loss of off-site power.

MR. BENDER: What is the difference between that and the hurricane?

MR. ISRAEL: It has torn the siding off the

diesel generator building, and you've got pouring rain and water, and you fail the off-site emergency power.

MR. BENDER: It is the structural integrity of the housing.

MR. EBERSOLE: You mean they have a tin house around the diesels? That's the way it's done?

MR. ISRAEL: It is metal sheathed, as opposed to being concrete.

MR. EBERSOLE: Well, the implications of that shoddy design ought to be noticed with respect to other features of the plant.

MR. KERR: They put metal sheaths around them.

MR. EBERSOLE: Rolled metal bed.

(Slide.)

MR. ISRAEL: These are dominant core melt sequences for core melt with containment cooling. Containment cooling for this plant can either be fan coolers or they have sprays. I guess there were only a couple of things I wanted to mention here. The LOCA failure and recirculation mode, the Sandia estimate is about three times higher than the IPPSS estimate, and that has to do with the estimate of operator error, switching over from injection to recirculation for the large and medium LOCA's.

Another event that Sandia has picked up is a break in the component cooling water pipe. Indian Point plants, both of them, have headed together their -- each plant individually has their component cooling water headed together, so that the two or three component cooling water pumps can feed water into this headed piping system that would provide water to whatever the auxiliaries were as opposed to some where you have redundancy and one is only providing it to one train of the ECCS, et cetera. So this is functionally redundant.

The IPPSS report did look at a failure of the component cooling water pumps as an initiating event, and its probability of going to core melt. The frequency for that was rather low. So we postulated, all right, we have this headed together system. If we had a pipe break in the component cooling water, I would then lose the ability to cool the reactor coolant pump seals. This plant or the analysis of this plant -- it's a Westinghouse plant -- indicated that based on the information put forward, that the pump seals would fail within a half-hour if they didn't have cooling.

This obviously goes to a LOCA.

MR. KERR: What is meant by a pipe break in this context, that the pipe is broken so seriously --

MR. ISRAEL: All the water runs out of the component cooling water system. It has about 28,000 gallons.

MR. KERR: This is a system that operates at roughly what pressure?

MR. ISRAEL: I don't know, 50, 100 psi. It is a low pressure system.

MR. KERR: And the probability of that pipe break is assumed to be about what?

MR. ISRAEL: Well, herein lies one of the difficulties. The values that were used were the pipe break frequencies that IPPSS had provided, the general pipe break frequencies that ultimately go back to WASH-1400, whatever that data base was in WASH-1400. For such a low pressure system, one would think that those are obviously conservative, those pipe break frequencies. WASH-1400 pipe break frequencies were geared to high energy piping systems, and this probably doesn't qualify.

MR. BENDER: Let's look at some other aspects of it. Do we have a discovery probability in this thing? Presumably this is a correctable condition, if you have time to correct it.

MR. ISRAEL: I only have a half an hour. Here is the problem. Component cooling water cools the

reactor coolant pump seals directly. I can also cool the reactor coolant pump seals with injection from the charging pumps. However, the charging pumps need component cooling water for their system, so even if I had a LOCA, my HPSI pumps would mitigate the LOCA. However, the HPSI pumps need component cooling water for their cooling.

Now they do have a backup system for both the charging pumps and the HPSI pumps. They can connect city water. But that means they have to run downstairs. There is a spool piece. They have to bolt in a piece of pipe, put in a valve, and that is probably not going to happen in a half an hour.

MR. BENDER: And the component cooling water lines that results from a half-hour time is about what size?

MR. ISRAEL: I don't have the answer for that. Those are the major items for that.

[Slide]

MR. ISRAEL: I will quickly go through Unit 3. The discussion for this would be the same as I described for Unit 2, and I'm not going to go over it again.

[Slide]

The fire situation for Unit 3 core melt no-containment cooling is the same. Let's see. Fire is the same as I discussed on Unit 2. The hot gas layer situation. Seismic is a little bit different situation. The seismic analysis here that the Indian Point people presented was for a failure of the diesel fuel oil tanks in the lines leading to the diesel generators.

If we have a seismic event, we are going to lose offsite power. This would essentially take out the emergency power.

The Sandia consultant, after having been sensitized to the roof falling in on Containment 2 and incapacitating the control room, looked at the ceiling in Unit 3 and it has the same type of ceiling that we have here. These panels, the immediate ceiling above the operators is egg crating. However, there is another false ceiling probably about 5 feet above that that is made of 50-pound panels.

I guess the consultant was from California and I guess ceilings always fall in every time you have earthquakes in California, so he estimated what the conditional probability would be for the ceiling falling in on Unit 3. This has nothing to do with banging of one structure against another. This just has to do with the earthquake rocking the grid structure such that the panels fall through and incapacitate the operators. That is why there is this larger difference. The factor of 2 has to do with the weighting factor on the hazards curve.

The tornado is the same. Those were the dominant events.

MR. BENDER: Which earthquake are we talking about?

MR. ISRAEL: This would be up around .6, .8 median capacity. This will probably be .80, I guess.

MR. EBERSOLE: Sandy, in your control room you spoke about the ceiling being egg crate. Is there a illumination by fluorescent tubes?

MR. ISRAEL: Yes, but they are not like this. They are located above the egg crating. Is that right, Buck; they don't have these light fixtures? The light fixtures, the illumination comes from fluorescent tubes above the egg crating.

MR. EBERSOLE: Does the egg crating stay in place in a seismic event?

MR. ISRAEL: Well, that would obviously come down, too.

MR. EBERSOLE: Well, while you always have siemic fixtures for the tubes, the tubes always fall out. Does this lead to implications of a monstrous version where we had one light fixture that fell into a control board?

MR. ISRAEL: I don't think so. That light fixture was the bulb. I'm talking about everything coming down. I think that's a different situation.

MR. EBERSOLE: Well, my impression is the tubes come out in seismic events. Whether they get to the floor or not is another matter.

[Slide]

MR. ISRAEL: Okay, moving right along. To answer the question that was asked about production -- this is Unit 3 core melt with containment cooling at Sandia. Small LOCA and failure of high pressure recirculation mode. The licensee's analysis looked at the failure data for a high pressure injection pump, and they had one operating failure in something like 40 hours.

This was during the testing period for a

half-hour or hour at a time. One of the pumps obviously had a failure in some amount of time. It gave them a rather high failure rate in a 24-hour period, which resulted in coming up with this frequency for the failure in the high pressure recirculation system. Sandia said they weren't any different on Unit 3 for Unit 2, and Unit 2's pumps had gone, I don't know, 600 hours, whatever the number happens to be, without any failures.

So they averaged the data together and said they thought that a better estimate would be a lower failure rate for the pumps to run for 24 hours. So the core melt frequency for this was reduced by about a factor of 5. Medium and large LOCAS increased again because of human error in switching from injection to recirculation. The component cooling water pipe break is included here.

Those are about the principal features of this slide. Are there any questions?

[No response.]

That is about all I have to say.

MR. KERR: Are there questions?

MR. EBERSOLE: One more question. Sandy, you showed a number that the tornado potential is 9.2 x 10 and loss of all AC was 5. The relationship

between those, does that mean that the important tornado damage is more than just loss of AC power?

MR. ISRAEL: My recollection -- I'm talking off the top of my head -- is that that tornado took out the service water pumps.

MR. EBERSOLE: That would account for the larger number.

MR. OKRENT: Is there a summary available of what transpired in this meeting on September 1?

MR. ISRAEL: Yes. In fact, I have put together some of the memos for you, Dr. Okrent. I didn't bother putting that one together because the indication on the fly sheet was that ten copies were sent to the ACRS.

MR. BENDER: Let me ask a couple of questions just for clarification.

MR. ISRAEL: Yes, there is a memo available.

MR. OKRENT: What were the principal outcomes of the discussion, would you say, or what are the things that you expect to receive major reconsideration, if anything, and so forth?

MR. ISRAEL: I don't think that the Sandia numbers are going to change because of the interaction at that October meeting. The Sandia numbers may change because at that meeting the licensee offered up his

Appendix R modifications for Unit 2. He also offered up a fix for the roof banging together, so the Sandia numbers would probably change because of specific modifications that the licensee is proposing.

MR. KERR: I'm sorry, I don't understand the "offering up the fix for Appendix R." Did you mean to say he was going to implement those?

MR. ISRAEL: That's right. Everybody is going to implemant Appendix R, but he said this is my Appendix R modification. This is what I propose to do to meet Appendix R.

MR. BENDER: If you meet Appendix R and you make the structural fix that is being suggested, what answer do you get?

MR. ISRAEL: Okay. You want me to postulate for you. That's what I'm supposed to do. Let's see. Here is core melt no containment cooling.

[Slide]

These numbers dominate the core melt frequencies. So we are going to knock down seismic, we are going to knock down the fire, but we are still left with hurricane. The Sandia consultant after this meeting -- or actually before this meeting was in the process of evaluating what the hazards curve is for a hurricane at the Indian Point site.

The licensee also has a program going on, an additional study to evaluate what the hazards curve is, what the fragilities are, actual fragilities with the building, the effect of other buildings in the area, a much more refined and intense study to come up with a better handle on the hurricane number.

Mr. Denton, at the time the study came out, when he saw these numbers instituted that he would be alerted when a hurricane of that magnitude was moving up the coast and could threaten New York, and at that point he would potentially take action. Conceivably, if one shut down the plant x hours before a hurricane arrived, even if it took out all electrical, you could be so well cooled that you probably could exist for many hours without having to do anything.

MR. KERR: I'm sorry?

MR. ISRAEL: There were two courses of action: sharpen your pencil or do something pragmatic.

MR. KERR: Are you talking simply about a conjecture or about a possibility?

MR. ISRAEL: Evidently we are tied into --

MR. KERR: I know you have warnings, but I thought you said Mr. Denton might see a hurricane somewhere down in South Carolina and decide to shut down Indian Point. Is that for real; that is not just

over-coffee talk?

MR. ISRAEL: Mr. Denton is supposed to be kept apprised of hurricanes moving up the coast, and his actions will depend upon what his interactions are with the meteorology people, et cetera.

MR. OKRENT: The seismic review of the Indian Point PRA sort of broke its comments into three categories. It was less than a factor of 2. It was sort of treating them as small and things that you might not carry along, if I recall correctly. If it was 2 to 10, it was moderate; larger than 10, it was big. They mentioned a variety of things that might introduce a factor here or there. Sometimes the factor was only qualitatively assessed, most of the time.

The seismic contribution isn't small no matter which column you are looking at, so in fact a factor of 2 on that number is really quite different, for example, than a factor of 2 on Event V. In fact, it is different by more than a factor of 100 on what is presented here. How does the staff propose to get some kind of a quantitative handle on the other items mentioned in the seismic review but not included in this particular revision?

MR. ISRAEL: At this point in time, Sandia is supposed to, when it complete its report in December, is

supposed to come up with estimates of uncertainty. The extent to which they encompass all those qualitative aspects, I cannot say.

MR. OKRENT: It may be that the dominant event doesn't have a big uncertainty; that's possible. But in reading it, there are things left open. Similarly, as indicated in the hurricane discussion, it was sort of --

MR. ISRAEL: You see, we are always going to have this problem, Dr. Okrent. When you talk about uncertainty and ignorance, it is always going to be there. All we can do is try to estimate. The licensee at the meeting didn't even want to argue about this factor of 2. He said, look, I'm going to put a bumper in, I'm not going to quibble about whether it's 2 or 4 or whether my number is right. I'm going to put a number in, I'm going to correct it.

Similarly the fire situation. The hot gas layers. There is lot of argument going on about whether -- exactly what type of cable is affected and whether that hot gas layer only affects a foot from the ceiling, what have you. The licensee is coming up with proposals and saying, look, given that I have a failure of all my electrical in that area, I'm going to provide an alternate that will provide specific functions that I need, so if there is a fire in that area, regardless of

what its frequency is, I'm going to have an alternate route. I guess in a sense we are being better served by the people moving forward rather than just sharpening their pencils.

MR. KERR: Can you put that comment in the context of Appendix R? Is the applicant going to make changes because of this PRA or is he going to make changes that would have been required by Appendix R for both or neither?

MR. ISRAEL: Both.

MR. KERR: So there are some things he will do because of this PRA that he would not have done just because of Appendix R?

MR. ISRAEL: I think what this study has pointed out, and people may quibble with what I'm about to say, is they said, look, if I don't have cooling to my reactor coolant pumps for a half-hour, I have a LOCA and I have to provide cooling for that, so this opened up a whole new area in terms of component cooling water and providing HPSI, providing the HPSI capability in the event that you had a fire.

Prior -- I will make this a guess -- prior to this study, people probably were fixating on probably only the auxiliary feedwater system, so that I will guess that this study, then, has opened up the potential

for another area to pay attention to in Appendix R.

MR. EBERSOLE: May I ask a question, Sandy? If the five items there on the right, or four, rather -- we know they are not the totality of all the matters that will produce core melt with no containment cooling, but at least it is some of them. Those numbers up there indicate that something has got to be done, lots of things have got to be done. They sum up to an unacceptable totality. What is contemplated?

MR. ISRAEL: Like I told you, that the licensee has proposed a bumper and has proposed something here in the fire space that will reduce those two numbers.

MR. EBERSOLE: Those two? What about the top number?

MR. ISRAEL: The licensee is sharpening his pencil on that. The licensee is over here in this space. He is over here (indicating). Mr. Denton is --

MR. EBERSOLE: When is he proposing to do something?

MR. ISRAEL: The licensee's analysis or reevaluation of the hurricane is January -- the dates keep slipping.

MR. EBERSOLE: PWRs are supposed to have a remarkable capability for staying in hot standby with

just a little bit of water and a little bit of power. Evidently this shows that this one is not rigged to do that. I'm talking about the secondary coolant to atmosphere. What you are evidently telling me is that seal cooling is not provided for in that mode, that they need service water.

MR. ISRAEL: That is right.

MR. EBERSOLE: They need service water, which is lots of power. They can't get along on a feedwater pump.

MR. ISRAEL: They don't have electricity.

MR. EBERSOLE: They lose their major source of electricity and they don't have any minor source to run the small auxiliaries if necessary.

MR. ISRAEL: That's right.

MR. EBERSOLE: Which is no big deal to provide.

MR. KERR: Was it the case at Indian Point 2 that subsequently one did not have to take into account the effects of hurricanes?

MR. ISRAEL: I can't answer that. Indian Point 3 --

MR. KERR: I can't understand why one would have to design for tornadoes but not for hurricanes.

MR. ISRAEL: That is out of my area. I'm not able to address that. I don't see anybody from the Staff

that is here on that.

MR. KERR: I am trying to discover what the PRA would reveal that the requirements for an emergency diesel wouldn't have taken care of. What is it about the PRA that an emergency diesel is supposed to function --

MR. ISRAEL: I don't know this hurricane is --

MR. KERR: It is not unusual to talk about hurricanes up the east coast.

MR. ISRAEL: I'm not familiar with what the design criteria are for hurricanes in plant design criteria. I can't answer that. And there isn't anybody here on the Staff that works in that area here today.

MR. KERR: Are there other questions?

[No response.]

You have indicated, I think, two things that are likely to be changed as a result of the PRA. This is what I might call an augmentation of Appendix R. Apparently something is going to be done about possible mitigating fires which is beyond the requirements of Appendix R as you understand it.

MR. ISRAEL: No, Appendix R is sort of broad. It says to provide alternate cooling.

MR. KERR: I knew Appendix R was rather broad. That is why I'm surprised that there was

something here that Appendix R was not equipped to deal with.

MR. VARGA: Steve Varga from the Division of Licensing. As you know, we are all working on a schedule for implementation of Appendix R that goes something like this. In July, all the operating reactor utilities had to provide their Appendix R analyses, which they did, Indian Point 2 and Indian Point 3 being ones that have provided some mitigation features. Some were deficient in what we are evaluating.

As a result of receipt of the PRA and review of the PRA indicating the dominance of the fire risks categoris, we accelerated the reviews of the submittals and the status of the plants concerning Appendix R. We made visits to Indian Point 2 specifically with a fire team to evaluate the status of the fire protection and particularly the deficiencies that should be corrected as a result of Appendix R.

As a result of that visit and the deficiencies that were identified and the deficiencies in the submittals made by the licensee which will take some period of time to correct, the Appendix R reviewers tell me that the deficiencies identified in the PRA, which we have separated as a subset -- for instance, reactor coolant pump, lack of cooling water and hard wiring

alternate means of getting power to the pumps that provide the component cooling water -- as a result of the PRA we have gotten a commitment from the licensee that prior to startup, he will fix those specific things that have been identified specifically in the PRA as dominant risk contributors.

However, the Appendix R reviewers tell me that a properly conducted Appendix R review would have found and encompassed all of the deficiencies identified in the PRA and that the Appendix R review and the Appendix R corrections will correct and would have corrected the deficiencies, but the time scale is such that with our review and approval and then the modifications, and the rule allows a certain period of time for these modifications to be implemented, we have expedited those three or four things with the licensee and he has committed to complete those, which are included in the report that I am sure the ACRS has received, and the letter to the licensee outlining those specific corrective actions that he will take prior to restart; but the entire Appendix R separation criterion, the lighting and all of that will still take place at some time in the future.

MR. KERR: That is very helpful, Steve. What I am trying to identify is what change in risk may

result from the PRA. That is, what things are or are likely to be fixed up because of the PRA that would not otherwise have been fixed up. If I interpret your remark correctly, fire protection is not one of these, because a properly carried out review of Appendix R, which I am sure the Staff has done, would have caught this. So a PRA was not necessary for that.

MR. VARGA: Absolutely. That is the specific question I ask of the people doing Appendix R reviews.

MR. KERR: Now, one thing that has been mentioned that apparently existing regulations would not have changed is the seismic hazard. There is going to be a change made, I think, as a result of the PRA which would not have been made as a result of existing regulations, which calculations indicate will reduce the risk of a seismic contribution to core melt.

You also indicate, I think -- well, the answer to this question is not clear -- that there has been identified a contribution to risk from hurricanes which would not have been identified with existing regulations.

That one puzzles me because I can't understand why a diesel structure in this location would not have been designed to withstand an historical hurricane, and I think we are talking about historical hurricanes,

aren't we, not something considerably beyond the historical hurricane?

MR. ISRAEL: I think we are talking about something about 140 miles an hour. I'm not sure that's historical.

MR. VARGA: I don't know the specific and I can't recall. I wasn't involved in it at the time, the specific licensee and bases for Indian Point 2 and 3. But I am sure that winds, tornadoes, and hurricanes were part of it. I do recall that with the loss of offsite power there was the alternate gas turbine arrangement that, although not particularly in all of its attributes was what one would consider a first rate reliance for need on emergency power, but nevertheless it was available. It took some period of time to start, and part of the corrective actions we are asking for in the interim before all of Appendix R is completed is the ability to start that gas turbine in a certain period of time and the procedures to be available. I don't know whether or not the Indian Point PRA took into account the gas turbine availability, but the assumption is that it did. And what the licenseing basis was for hurricanes I do not recall, and what additional information might have been found from the PRA on hurricanes I don't know.

MR. EBERSOLE: May I ask a question, Steve? On the other side of the coin, did you see anything in the Appendix R investigation that you didn't see up here relative to fire?

MR. VARGA: I can't answer that question. I don't know.

MR. KERR: Mr. Israel, will you help me further? There are these three things, two things, I think, the seismic and the hurricane risk, that would not have been fixed up and presumably will be fixed up because of the PRA. Is there any other major contributor to risk that is fixable and is likely to be fixed up as a result of the PRA?

MR. ISRAEL: That is the area of what we ultimately do with the PRA results. They are under review and become part of our testimony for the hearing, so I don't have a definitive answer to give you at this point.

MR. KERR: I am not so much looking for things that have been committed to but things that are fixable. This really doesn't just have to do with Indian Point. Here is a very elaborate, very intensive PRA, and presumably one of the virtues of this, at least if one believes the ACRS, is that going through this sort of an exercise locates contributors which can then

be fixed. Even though maybe one doesn't believe in numbers entirely, there is a qualitative evaluation here.

I have indicated two things, hurricanes and seismic, and maybe they are big enough so that that is really a major contributor, but both puzzle me a bit, however. That is it, as far as you are concernad, of things that are major contributors that are fixable?

MR. ISRAEL: That is what I made in my comment right now. Ashok, did you want to make a comment?

MR. THADANI: When the licensee submittad the PRA, they wrote us a letter that went along with it in which there was a long list of areas where they felt they could make improvements and they were taking steps to go ahead and make those improvements because they felt they would not only help the risk, but there were about 10 or 12 items.

MR. KERR: ACRS probably has a copy of that letter somewhere.

MR. THADANI: Yes. If I recollect correctly, a large fraction led to integrity tests, flow verification tests. Mostly they seemed to be procedural.

MR. ISRAEL: One of the fixes was in the battery room, Unit 2. They were going to shore up the walls. This had to do with the seismic potential problem.

MR. VARGA: I might point out one thing. As you know, this Indian Point 2 and 3 at the present time is a highly contested hearing. Today we have the prehearing conference going on in the New York area. There are a series of questions that the Commission has asked the Board to explore. The Board has admitted a number of contentions. The Board has asked specific questions of its own. We are in the process of preparing testimony. At the same time, life goes on in other areas with regard to Indian Point 2 and 3, that is, the Three Mile Island event items as well.

Exactly what the use will be of the PRA as we come to the conclusion of the hearings and come to the conclusion of our reviews remains yet to be seen. As far as the requirement from the Staff for the licensee to make corrections regarding the Appendix R submittals, we are on quite firm regulatory ground there. As far as those items identified in the PRA, which go in some instances beyond the present design basis, the licensee, as Sandy just pointed out, has volunteered fixes, the bumper and some other areas that he has volunteered.

I am sure in preparation of his testimony which he will be filing as a result of the Board order that I am sure will come out as a result of the hearing today, in the testimony he files I feel sure that he is

probably already making a list of items that he feels he will correct based upon the PRA. What additional requirements we will have him do will remain to the conclusion of our testimony and our recommendations.

MR. BENDER: Steve, these things will be in the nature of backfits, don't you think?

MR. VARGA: Yes.

MR. BENDER: I guess one would have to ask, if it is a backfit, does it involve a substantial reduction in risk? What is the measurement criteria?

MR. VARGA: I don't know what the measurement criteria will be. The measurement criteria in the announced policy statement is the ALARA, the $1,000 per man rem. There have been proposals, of course, that people have been discussing about various criteria, the monetization of risk approach, but I am not sure we have established a consensus or even an approach yet.

MR. BENDER: The policy is out for comment. It is just not in the regulatory rule yet, is it?

MR. VARGA: No, it is not. It is still out for comment. But it has at least some tacit weight in our deliberations, knowing that it is a statement of policy, that it is out for comment.

MR. BENDER: I wonder how the hearing board will address something like that that is in a

deliberative state itself.

MR. VARGA: Well, in the present hearing at Indian Point, there has been, as you know, a change of chairmen, and consequently there is going to be -- there have been already some changes in the questions and the contentions, but one of the items I am sure we will be addressing in response to the questions the Commission has asked will be the Commission policy statement and our perception of its role and what use we would make of it.

MR. BENDER: So it doesn't make any difference that the Commissioners have not yet adopted a policy; it is the policy?

MR. VARGA: I don't think so, no. I say we use it in terms of guidance as it evolves to see what effect it has on our deliberations.

MR. KERR: Mr. Okrent?

MR. OKRENT: Later in today's agenda there is sort of a general kind of discussion available. I am wondering, does the Staff expect to be here for the full meeting or are they going to fold up their tents as soon as they have made the presentation on Indian Point?

MR. THADANI: Dr. Okrent, we were planning on staying here part of the time, until about lunch.

MR. KERR: We can take care of that, though,

by just not having lunch until 4 o'clock.

MR. THADANI: Let me rephrase that.

[Laughter.]

MR. KERR: Did that respond to your question?

MR. THADANI: I would really appreciate it if we could leave somewhere around 1 o'clock, and if you think there are some other aspects we should be discussing in terms of plants and so on, perhaps we could do that this morning.

MR. KERR: Why don't we decide whether the Staff has answered all our questions by 1 o'clock. If they have not, we may plead with them.

MR. OKRENT: Okay. I would like to come back, either now or after the break, as the Chairman prefers, to just find out a little bit more about where the Staff plans to go with regard to what I will call the technical review of Indian Point 2 and 3. In other words, what further kind of technical reviews you think are relevant and how you expect to go at them and so forth. Maybe we could let them think on that while we have a break, Mr. Chairman.

MR. KERR: I was going to ask a very similar question: namely, not that you have got this thing, what are you going to do with it? I think I heard either they are not sure what they are going to do with it or

they cannot talk about what they are going to do with it because they are in litigation; but I hope we can get some more definite answer.

I am also more interested in: Is the Sandia position also the Staff position, and if it is not, how does the Staff plan to arrive at a position?

Mr. Mark, we have kept you quiet too long.

MR. MARK: That is commendable. I have a very vague question, and I don't really expect an answer, and certainly not a definitive answer. It goes to Steve Varga, in part, and maybe Israel and maybe the Staff generally.

We have here a hearing. Obviously the things to be discussed have been worked over and settled and the reg guides have set down regulations to determine the admissible questions, points on which the proceeding is to be held. Is there any room, is there any mechanism, is there any tendency or any possibility, supposing the Staff sees something that is not covered in the reg guides but represents in their view an actual issue? I mean here is a window that is open that shouldn't be there, or whatever.

Is there any way and any inclination to act on such things, or is one really tied down and guided by the wordage that is in place?

MR. KERR: Is that question directed properly to you, Mr. Varga?

MR. VARGA: Yes. The answer to that is we are not tied down. As an example, Harold Denton, when we received the Sandia results and had the presentation by Sandia, I indicated the dominant contributors. As a result of Harold's perception, we had discussions with both Indian Point 2 and 3 management, upper management, and specifically discussed the concerns, the concern for the seismic hazard, the concern for the fire, and the concern for the hurricane.

We had a seismic evaluation team up at Indian Point 2 and 3 specifically looking at the pump problem, the ceiling problem, the diesel generator, the diesel fuel tank problem, and we had a team up there for the fire problem and discussed with Indian Point management actions which would be prudent to take without waiting for a specific direction or an evaluation on the part of the Staff.

I think as a result of that phone conversation that there were positive steps taken by the utilities in such things as the design of the bumper and the volunteering of the bumper. My perception is there is an acute sensitivity to act immediately on those areas where it appears a significant dominant risk contributor

has arisen without waiting for an evaluation of a value impact statement but to see what can be done immediately, and that has been done.

MR. MARK: Steve, I think that is --

MR. KERR: I think one should also add, I think, the uncertainties of the Staff numbers.

MR. MARK: That sounds actually very good to me. I was fishing, I suppose, for the possibility that seismic, of course, is recognized on the agenda as something that has to be discussed. Fire, also. But I am wondering, supposing you or someone you are in touch with sees something that isn't on the agenda and he says, good heavens, this is bad, or it could be better. Is there a mechanism and a way of introducing that into the discussion apart from the tag enumerated items? That is, he finds -- I said an open window. Just to think of something that wasn't by any chance on the list of things to check. Is there a straightforward, easy, customary way for such things to get into the argument so that they indeed have to be given attention?

MR. VARGA: If I interpret and restrict your comment to Indian Point for the moment, Indian Point 2 and 3, as a result of the PRAs for both Indian Point 2 and 3 and for Zion, and the discussions that Sandia has had about the mechanisms and consultants we have had in

place reviewing those, the mechanism of surfacing outliers, surfacing areas that have not been considered will have to come through that particular mechanism in terms of the reviewing of the PRAs.

We always had in the regulatory process, there is always the mechanism that any reviewer doing any piece of work, where he finds something that has not been taken care of, he has the obligation to surface that immediately, and he has done that. We have seen several instances of that in the past year, of that kind of a sensitivity taking place.

But as far as Indian Point 2 and 3 goes, in the answers that we are preparing now, the testimony that we are preparing, the testimony that the intervenors are preparing on the risk questions asked by the Commission, there is a great deal of work going on, as you can see, in reviewing the Indian Point PRA, in the Sandia review of the Indian Point PRA, in our review of both the Sandia evaluation and the Indian Point PRA, and in that mechanism, if a problem or if an outlier is surfaced, we would immediately act on it.

Now, whether or not the outliers have to date been properly surfaced or not, I guess the confidence I have is only that we have a very extensive peer review going on, we have Sandia reviewing that review. We

have, I am sure, as the hearing progresses, we have a large body of interested public participants that will be carefully and searchingly examining our testimony, and whatever surfaces in that mechanism, we would act on. Those are the mechanisms wherein those kind of concerns would surface.

MR. MARK: Thank you. I believe that covers my point.

MR. KERR: Other questions of Mr. Israel other than the ones he is going to think on?

MR. BENDER: Just one having to do with Steve's observation, that I guess certain outliers are being corrected without considering their value, their cost/benefit relationships and the like. Is that a correct interpretation?

MR. VARGA: I didn't mean to say that irrespective of the cost, that they were being corrected, but in the identification of the problem, the consensus was and the consensus is that those corrective actions that could be taken to significantly reduce the dominant risk contributors were so worthwhile.that one didn't have to go through and wait for a formalized evaluation. Now, there may be many other things in the PRA where we might have to in terms of backfit, in order to establish the requirement, in spite of the utility's

objection we will have to go through a very careful evaluation to make the point.

But in those cases where the problem has surfaced and the utility has recognized the problem and has acted more or less in consort with the Staff's considerations to correct the problem without any particular regulatory action on our part.

MR. BENDER: There will always be dominant risk contributors. When you get rid of the dominant ones now, the next group will become dominant. I am still concerned about the matter of where to draw the line, and I think I will just leave it there.

MR. EBERSOLE: Steve, before you run off, we mentioned the Appendix R studies you have done which interfaced with this. You mentioned doing some seismic studies, some considerations of hurricanes and tornadoes. Indian Point was also the beneficiary of a system interaction study. Somewhere somebody like yourself has got to be at the top of this great heap of studies and see that appropriate strings are tied to each on of these as inputs to this comprehensive thing here.

How many inputs have gone into this? Have you picked them up and done that as a summary operation of all of these, or are they just left out there by

themselves?

MR. VARGA: Let me answer the question. There are none out in left field that I know of. They have not all been completely integrated, but the work is under way to do that. You picked a good one, the Indian Point 3 system interaction study. You recall they used the auxiliary feedwater system as the model. They had extensive discussions with you all. One of the multi-plant action items we have, I think it is C-14, is the seismic capability of the auxiliary feedwater systems. As you know, we have gone out to all the utilities with a generic letter. They have all responded. We have received the Indian Point 3 response to our generic letter, and the Indian Point 3 response includes the items that they found from the systems interaction study.

We have reviewed those items, the response to the seismic capability of the auxiliary feedwater system and have some concerns with it. We are right now in the process of reviewing both Indian Point 2 and Indian Point 3 based upon the two separate submittals but using the submittal from Indian Point 3, which seems to have a more sophisticated review as a result of the systems interaction study.

So we have asked, and I think Sandy can

correct that, perhaps, the Indian Point PRA people, PL&G, I think, is going back and taking a look to see what the systems interaction study is on the auxiliary feedwater system from the PRA, but I don't know of any studies -- and I am not an expert on all the PRAS -- but I know of anything associated with Indian Point 2 or 3 that seems to have a bearing on the PRA we are following.

MR. EBERSOLE: Thank you.

MR. KERR: We have a ten-minute break beginning now.

[Recess.]

MR. KERR: Mr. Thadani, is someone prepared to make some comments in response to the questions just before the break?

MR. THADANI: If I understand your question correctly, Mr. Kerr, you were interested, I think, in knowing, now that we have these PRAs, what are we going to do with them.

MR. KERR: Yes, sir.

MR. THADANI: Obviously, one aspect is to review the PRAs to get a better understanding of what are the factors which might strongly influence risk: that is, identification of dominant contributors, to look at these contributors further to see are they dominant because perhaps our current regulatory requirements have not been implemented? An example is obviously Appendix R in this case.

MR. KERR: As Mr. Bender has pointed out, no matter what plants you review, you are going to find some dominant contributors because some are going to be bigger than others. Are you just looking for dominant contributors or are you looking for dominant contributors that are significant?

MR. THADANI: We are looking for dominant contributors which are significant. I think "significant" is a rather subjective word.

MR. KERR: That is part of the question: Is it at this point subjective?

MR. THADANI: It is largely subjective. We do not have safety goals. As Steve Varga earlier pointed out, we do have this Commission position which went out for comments. One thing we would be doing is to take those considerations and use them only as guidelines to point out which ones are dominant in relation to both criteria if they were adopted.

So you are quite correct. There is some level beyond which one need not really pursue the sequences with any vigor. It is subjective to a large extent, but the proposed goals are used only in the aspect that if estimates are in those ranges, they would be considered important.

Now, one point that I thought did not come out, at least in my perspective, was I quite agree with Mr. Bender that you do have to consider value impact, and I think the NRC in general has been putting more and more attention on value impact, recently, anyway. So when you look at these dominant sequences, I am not sure that one would go out and say you have to fix this. The question to be asked is are the requirements being met? If the answer is yes, then one would have to sit back and say, well, how much is it going to cost me to make

any additional improvements?

The value impact, I think, is going to be a very important part of any actions which will be required outside the regulations. That would be the general approach we would be following, unless the Commission does come back with a definitive statement on baseline risk.

MR. BENDER: I don't know where it stands right now, but I have the impression that some part of the NRC is vigorously pursuing something called a backfit rule and that it may go out for comment soon, too. I am not sure what is going to be in it, but I suspect that whatever people have in mind ought to be cranked into the evaluation process to see whether the PRA approach and the backfit rule are even compatible with each other.

MR. MARK: Mr. Chairman.

MR. KERR: Yes, sir.

MR. MARK: Has there been before I managed to get here any discussion of this recent report from Sandia on the worst case accident?

MR. KERR: No, sir.

MR. MARK: I'm not prepared to discuss it either because I have not seen the report either, but -- as given in the newspapers, it presents a tremendously

impressive picture of a disaster. And while I don't think that things like that should influence directly the numbers one decides to apply in a PRA or any study, it is necessary nevertheless to give thought to how to be prepared to comment or how to relate one's own comment to that comment. And while I am sure it is not really part of the discussion today, it is certainly in my mind as a thing that overhangs, glowers over some of the things we are talking about.

MR. KERR: I did not take that as a question.

MR. MARK: It is not really a question unless Mr. Thadani would wish to comment on the thought they are giving to responding to this rather new and rather troublesome-looking event.

MR. KERR: Do you have something on which you are willing to comment, Mr. Thadani?

MR. THADANI: I would just as soon not comment on that aspect at this stage.

MR. KERR: Mr. Okrent?

MR. OKRENT: I have a few questions. A specific one is I think Mr. Israel indicated that one of the technical outcomes from the PRA and the review of the PRA is the concern that you might get a small LOCA arising from a loss of reactor coolant pump seals because you lost power to the systems, that you lost

cooling water for the systems that put water in the pump seals, and it was sort of like this was something new.

It is my impression that in 1978 at the ANS meeting on probabilistic safety, that Fred said that they had looked at the question of station blackout in France and arrived at the judgment that it was a thing that might occur with the frequency of something times $10^{-5}$ for even an extended period of time, and that they were going to put in additional systems that would provide cooling water to the reactor coolant pumps seals, and in fact I think they have done it and it is either run from steam or from a dedicated diesel that is supposed to be able to work even when you lose the other systems.

So I am a little bit surprised that it seems like a new event to somebody, and I am also surprised that it has not been looked at harder in this country as well as some other things of that sort. That is just an aside; that is not a question, Mr. Chairman.

MR. KERR: A speech.

MR. OKRENT: A speech, yes. I would like to get back to the general question of how the Staff expects to proceed with regard to what I will call the technical review of risk for Indian Point. I think we do have what I consider to be a good, not perfect, but a

good PRA. I think we have the benefit of what the licensee considers to be a good review of the initiating event portion from Sandia. I don't know if there is going to be a report or is a report on the risk, the overall risk from BNL. I assume there will be?

MR. THADANI: At this stage there is no report yet from Brookhaven National Laboratory. In the analyses that have been discussed with you in various meetings, the Staff is rather busy now writing testimony for the hearings.

MR. KERR: Mr. Thadani, you are not coming through.

MR. THADANI: I will try to stay pretty close to it. The Staff is pretty busy putting together testimony for the hearings now, and I would expect anything that comes back would get lower priority. The first priority is to prepare our testimony, and it is our intention to have one report that would not just include Sandia's assessment but it would include Brookhaven's assessment as well as the Staff's studies, which would give the total picture in terms of the review of IPPSS and our thoughts on what the risks might be.

I would expect that to take place not in the next two or three months but perhaps within six months.

I do not know what the schedule is going to be in terms of hearings. It has changed and continues to change, and as Steve pointed out, there is a prehearing conference today and there will be some discussion of schedules. But I would not expect us to come up with any additional reports besides the Sandia report on Indian Point. After we have prepared our testimony, then we can focus attention on putting together a report.

MR. OKRENT: Let me pursue this matter. I am trying to find out what constitutes, I guess you might say, an adequate status of technical studies. What I said was we had good PRAs and a good review, but in fact if you read the Sandia letter, it says we were able to spend something on the order of two manyears, something like this, and clearly there are parts of it that they were able to do really in quite a detailed fashion because they had the benefit of having looked at systems like this. They knew what kind of data to expect, et cetera, and spending another half man-year in those areas mght not change things significantly.

On the other hand, there are many areas where things were treated really in what I would call a review fashion and questions were raised or engineering judgment was a very strong input into what was done rather than even secondhand, let alone firsthand,

looking in detail, and certainly fragilities and seismic evaluation is one example of that.

I am trying to understand how the Staff will decide what constitutes an adequate technical depth of review. This depends on the purpose, certainly, so I don't expect that one necessarily has the same answer in looking at it on Indian Point as if you are trying to make a judgment on some of the SEP issues, which tend to be secondary in nature at one of the SEP plants, but for the Indian Point plant, what constitutes an adequate review, why, how do you propose to incorporate in this judgment these areas that have been looked at, as I say, only in an incomplete way in a review mode. And in fact, as you know, there are things that are not included in anyone's PRA except under the category "other."

MR. THADANI: I will take a crack at it. I don't think I have any real answer to your question.

MR. OKRENT: I don't think I have an answer either, but I think we ought to talk about it.

MR. THADANI: We don't have much experience reviewing PRAs. We have consultants who, in my opinion, have had extensive experience in both being involved in providing some sort of consultation as well as having conducted PRAs. There was discussion of what kind of an

effort it takes typically to review certain pieces. One can develop some rather arbitrary standards, perhaps, and say if it takes you ten months to do a study, you ought to at least spend a month reviewing what was done. It is rather arbitrary. As one gets more and more experienced, hopefully one would take less time, or the reverse of that might be that until one gets a lot of experience, one should spend a fair amount of time reviewing these studies.

Two factors. We looked round to see how much help we could get in terms of reviewing these studies, and there was some consideration of schedules as to when we might need some input. A classic example, as Sandy pointed out earlier, is Indian Point. We took the Indian Point study. We got it sometime, I believe it was, in March, the middle of March.

We knew we had hearings coming up. We wanted to do two types of reviews. One was a fairly quick review followed by a more comprehensive review. The quick review was to be done in about four months. The more comprehensive review we said would take something on the order of a year or so. As the hearing schedule changes, so does our review process.

We have, in my opinion, some of the best people, who understand data, who understand the

functional characateristics of the plants, who have sensitivities in terms of how these analyses are done; and added to that, I think, are the detailed studies that have been going on for the past two to three years in terms of containment assessments.

I think we have gained a lot of insights from these various studies, and it is at least our judgment, and we could be wrong, at this stage that putting in somewhere around two to three manyears worth of effort in the large study such as Indian Point and reviewing it and providing at leas' what we might think is a balanced assessment is a reasonable kind of effort.

I think we don't know as yet if that is a correct statement or not. It depends on other groups reviewing our assessments and coming to certain conclusions, whether we did indeed look at things thoroughly enough or did we spend much too much time that we didn't need to spend. I can't give you an answer. I think we are all struggling at this stage.

MR. OKRENT: Well, again, there are areas which seem to be in need of additional information. If one looks through the Sandia letter and if we look at some of the ACRS consultant reports again, that there is additional information which may be of significance in arriving at a better base for engineering judgment or

whatever it is you are going to arrive at.

What I thought I heard implicitly was you are preparing a kind of final report with the input largely having been developed, except for such feedback as you get from the licensee and its consultant and that you might get at the hearing itself. It seems to me that one could look at the report and the review and so forth and out of this say, well, where are there areas that one should put further effort into and what kind of effort makes sense and so forth. I did not get the feeling that that was part of your plan or whether you thought that was not necessary, or maybe I am just hearing it incorrectly.

MR. THADANI: I am not quite sure I follow you, Dr. Okrent.

MR. KERR: Let me ask something that I think is parallel to Dave's comments, and maybe if he says yes, it will help. Earlier comments would seem to me to indicate that the Staff has an approach which attempts to compare the risks associated with the Indian Point operation compared with other plants as an inordinate contributor to risk.

In a discussion of the safety goals, if I remember correctly and if I interpreted the comments correctly, it was a feeling of at least that segment of

the Staff responsible for contributing to that study that the specification of performance of containment systems was sufficiently not well understood that the Staff did not want to put any quantitative criteria or to set any quantitative specifications for containment performance. It may be true of the Indian Point containment in as much detail.

I think there is an appropriate discussion of the source term to be used as one attempts to go outside containment. It seems to me both of these are a significant contributor to risk as contrasted with the core melt probability. If there is going to be a risk comparison, has the Staff decided how it is going to deal, for example, with these two issues, with which it seems to me there has been significant uncertainty identifed by the Staff and by others, and yet which are rather significant contributors, it seems to me, to what one finally calculates the risk to be? This is not all of your question, but it is that sort of thing.

MR. OKRENT: It is certainly a good example, and it makes a point. In other words, there are sort of two kinds of questions. One is on what basis is the Staff going to evaluate a judgment and make recommendations to the Commission with regard to things other than these things you are dealing with the

licensee on the telephone, the harder decisions which fall into a grey area. And then there is the other one, just from, let's say, the long-term point of view of trying to improve the usefulness and the quality of the use of the PRA. Is what has been done right in trying to study Indian Point; if not, why? The two are not unrelated. I think Dr. Kerr has certainly raised a couple of the things I had in mind. What we have been talking about today is in the core melt prevention area.

MR. THADANI: Well, the two aspects that you talked upon, Dr. Kerr, I indicated earlier that the Staff has had several discussions with the Subcommittee as well as the full Committee in terms of the work the Staff is doing on containment. With future plants you are quite correct, the Staff had indicated that at this stage we are not in a position to specify containment performance for various types of containments in numerical terms in this proposed safety goal consideration.

In terms of source term, there is a fair amount of work going on to try to come to better estimates of source terms. If you want to know some details about these programs, we do have Jim Meyer as well as --

MR. KERR: My question was, given what I

interpret to be a significant uncertainty that is not likely to be resolved as the Indian Point testimony is prepared, I was using this as an example of, it seems to me, rather significant but uncertain questions with which you have to deal at some point. Have you decided how you are going to deal with questions of that kind?

MR. THADANI: Well, again, I would like to hold off on one part, which is that there is significant uncertainty in the containment failure modes. If you would like to know generally what the Staff knows now, Jim Meyer can tell you that.

MR. KERR: You have decided to have an approach that you are going to use at this point even though there is a good bit of uncertainty in what you got?

MR. THADANI: We would have to reflect the results with the associated uncertainties. Obviously, that is the state of our knowledge now. There are clearly uncertainties. In those areas where there are uncertainties, one would have to sit back and decide what programs should be initiated if they are not already in place to try to reduce the uncertainties. It seems to me that is the central goal that such an organization ought to play to get a better understanding of the phenomenon.

MR. KERR: I interpreted your question as arriving at a cadre of things and there is another category where things are in reasonably good shape? Is that a valid interpretation? I am talking to you rather than Ashok.

MR. OKRENT: Well, that is certainly a good part of the question.

MR. THADANI: We are today talking to our Research Office. What areas need further work, at least in terms of probabilistic risk assessments -- and there are no big surprises, I am just telling you what I am convinced you all know -- external events, human reliability, source term. These are dependency analyses, and it is another area where one needs to develop perhaps better methods to try to identify and evaluate these dependencies and include them in the PRAs.

The sorts of areas where we are working with Research is to see what can be done in what time frame that they can provide which pieces. We hope to have a plan addressing these aspects withing the next three or four months.

MR. KERR: In your view, is the present state of the art such that one can use current results for decision-making?

MR. THADANI: I think one can use these

results as yet another source of information for the decision-maker. If these results point to some deficiencies, I think this is useful information to the decision-maker. If these results say what you are concerned about is not very important, then you look at the basis upon which the PRA came to that conclusion. So I do think this is rather useful information to the decisionmaker. Besides, I think they also help. I recognize your point on uncertainties, but I think they still help in doing the value impact assessments to see if there are not other areas that might be better pursued than the ones that we are pursuing.

MR. EBERSOLE: Let me ask a question, Bill.

MR. KERR: Just a moment. Do you want to consider this further?

MR. OKRENT: Just one or two more minutes.

(Applause.)

MR. MARK: One.

MR. OKRENT: I would suggest that you set up some small but conscious effort to summarize where in the Indian Point PRA there seems to lie the areas which are clearly important or may be important and where the effort expended to date, and I will say the combined effort, meaning not only in this case the licensees, contractors, and your reviewers, but even the research staff coming before it, may have been clearly insufficient or probably insufficient, and then to decide in those cases, can I tell by what I will call more technical assistance kinds of efforts, which I will put the review of Indian Point in, as contrasted to long-range research.

I am not against long-range research to give you approved methodology, but I am not sure that everything will fall in that category.

MR. THADANI: I know you didn't ask me a question, but I just wanted to make one point, Dr. Okrent. I talked about generalities, external events,

human errors, and so on, and yes, indeed, some aspects would be long-range. It is our intention to try to come up with a plan which would lay out what can reasonably be done in what time frame and what the expected return might be in terms of narrowing some of the uncertainties.

I certainly did not mean to imply that we were going to talk to Research, and that this is something we would be working on for the next ten years. We may well be, but we would like to try to identify what kind of effort is needed to try to narrow some of the uncertainties and in what areas. That is what I meant when I said we would be preparing a plan.

MR. KERR: The two minutes are up. Mr. Ebersole?

MR. EBERSOLE: When you start to review one of these things, do you pick it up at first and do sort of a general review of the skeletal aspects of what has been done, to see what has not been done? I was impressed by the consultants' report on the Limerick PRA, in that it doesn't consider external events. It would appear there would be some general criteria that says there shall be consideration of this, that, and the other, or you don't have to include sabotage because nobody knows what to do with it, but in some way, one should bound and identify the scope. Otherwise, why

bother with doing uncertainty analyses?

All these things start with subjective judgments as to whether you should include them or not, so to some extent all the PRA's start at the subjective level. What do you do to make sure they all get off on a common foot?

MR. THADANI: I think you are quite right. You have to have a certain amount of boundary, if you will, in the review. We have attempted to provide at least some level of guidance to the reviewers, and given the scope of this study, clearly, as you point out, Limerick does not treat external event. Given the study, which treats only internal events, the review is limited to the documents we have in front of us. One would start with the initiating events, the data base, the methods, the criterion, and so on.

We have attempted to provide at least some minimum level at which these reviews would be performed. In most cases, I think the reviewers have looked beyond those aspects. We have identified initiators that we should at least be looking for to be sure that those are treated. That is not to preclude them from identifying areas that we may not have had a priority in identifying, but there is that level of guidance that is given to the reviewers.

MR. EBERSOLE: It certainly ought to be important that you require a disclaimer which is clear and positive at the beginning of the report to what people are taking a comprehensive review of in a partial report.

MR. THADANI: I guess I would say a review of a PRA should always have a disclaimer.

(General laughter.)

MR. KERR: One, I think, last question on this topic before we go on to Limerick. Presumably the Indian Point hearings will discuss risk. I don't know what they will conclude. Either the risk is greater than or about equal to or less than. It is conceivable to me that a conclusion could also be reached if one explored this that it was in compliance with all existing regulations.

I am not asking what the Staff is going to do if this is the case, but does the Staff have a mechanism for dealing with the situation in which one would conclude that the risk is higher than average or higher than something or other and yet the plant is in compliance with all existing regulations?

(Pause.)

MR. KERR: Is a strategy being developed to deal with those eventualities?

MR. THADANI: I think the approach is to look at the Indian Point units and to see once they are in compliance regulations what the risk might be given these uncertainties. The staff's perception of risk from other sites as reflected in various studies, I think those would be -- that would provide the background for saying, what do we think the risk is for the Indian Point site as compared to the risk from other sites, but clearly, one would have to be sure that the other plant risk assessments that one is using, that the base was the same, that they also met the regulations.

MR. KERR: Since the regulations are not risk-based, it seems to me quite possible that one could find the societal risk, for example, quite different for two sites, each of which would be in compliance with existing regulations.

MR. THADANI: That is quite possible.

MR. KERR: The next question is, has the staff given thought to what it is going to do if the final results of the study are that the risk of this site is considerably above average, or maybe it will turn out to be considerably below average, as far as I know, but the plant is in compliance with all existing regulations?

MR. EBERSOLE: Bill, it seems to me you are talking about a degree of defined prescription.

MR. KERR: I am really trying to get out of him, once you reach this, what do you do next? The regulations are what determines whether you run the plant.

MR. EBERSOLE: You can interpret all over the map with the regulations.

MR. KERR: They may be loose, but they are the best we've got.

MR. EBERSOLE: The band width of interpretation can mean all the difference.

MR. KERR: I am trying to get the staff's approach to this. If you were responsible for interpreting these regulations, I would have a better idea of what would be done.

(General laughter.)

MR. KERR: Do you understand the question I am raising?

MR. THADANI: I understand your question, Dr. Kerr. I just can't -- I don't know what the answer is going to be. As Steve indicated earlier as well, our --

MR. KERR: Then a strategy is not being planned for this eventuality?

MR. THADANI: No, not really. At least, let me put it this way, not that I am familiar with.

MR. OKRENT: Well, watch the Washington Post.

(General laughter.)

MR. KERR: Are there other questions or comments?

(No response.)

MR. KERR: I suggest then that we go to the Limerick presentation.

MR. THADANI: We have, as I indicated earlier, Brookhaven National Laboratory reviewing the Limerick risk assessment. We just received the BNL draft document providing their review of the Limerick study. Just to show you how fresh it is, this morning I realized -- I was told that there is a substantial error in that document. The Staff has not yet reviewed that report. We have only had it for a few days. Nevertheless, we would summarize some of the BNL assessment results, and Mr. Chelliah of the Reliability and Risk Assessment Branch would summarize the results. We do have some people from Brookhaven to respond to some of your questions that you might have.

Staff has not had enough time to review this. We would like BNL to respond to those questions. We have not done enough --

MR. OKRENT: Is someone going to tell us what the substantial error is?

MR. KERR: Is it in the Limerick PRA?

MR. THADANI: There is a substantial error in the BNL report in its review assessment of the Limerick PRA.

MR. CHELLIAH: My name is Euralappa Chelliah from the Risk Assessment Branch. I will be presenting a summary of BNL's review results of the Limerick PRA.

As of October 15th, BNL reviewed the Limerick PRA, Revision 4, so BNL's review results are based on the review of Revision 4 of the Limerick PRA.

(Slide.)

MR. KERR: Try to stand reasonably close to that microphone, if you can.

MR. CHELLIAH: BNL reviewed the accident sequence analysis portion, and they have reassessed the core damage frequency. Here is a summary.

(Slide.)

MR. CHELLIAH: The Limerick PRA predicts 1.5 x $10^{-5}$. BNL's review is 1.1 x $10^{-4}$ per reactor year, which is a factor of several higher. You may be interested for the reason these additional support systems include three, some AC dependencies and DC dependencies. The BNL modified somewhat the fault trees, particularly in the area of fault trees for high pressure coolant injection system, the ADS, and the standby liquid control system.

Also, BNL updated some of the frequency values for all initiating events.

MR. KERR: Excuse me. Does number C imply BNL will be available to the Limerick people, or that they interpreted the data different, or that they used a different data set?

MR. CHELLIAH: BNL used the data from the survey of somewhere around about 210 BWR operating reactor experiences, so for example, in the transient frequency, BNL predicts --

MR. KERR: Did they use data that were unavailable to the people who did the original PRA, or did they interpret it differently? The term "revised" is used, and I don't know what "revised" means when they revised the frequency.

MR. CHELLIAH: They did --

MR. SCHWENCER: We have a BNL representative here. They might be able to help you.

MR. PAPAZOGLOU: My name is Ioannis Papazoglou. The answer to your question is, all of them. We have a slightly different data base, and we used a different approach. The approach was very similar to one that was used in the Indian Point and Zion PRA's. The difference between the approach that was used in the Limerick area and our revision was, we

did not give all of the credit that one would get if they had an operating plant, a plant that is operated for some period of time, and we said this is a new plant, and therefore the data went through a certain amount of analysis before.

MR. KERR: You mean new in terms of being a new model, or the fact that it has not operated yet?

MR. PAPAZOGLOU: The latter.

MR. KERR: Thank you.

MR. CHELLIAH: Let us move on to the next one.

(Slide.)

MR. KERR: Would it be accurate, then, if I may, to say that your results might more nearly reflect what one would expect during the first year or so of operation of the plant rather than being averaged over 40 years, or do you average over 40 years but give more weight? What are you then calculating as compared to what the Limerick people might have been calculating?

MR. PAPAZOGLOU: I will try to answer that.

MR. KERR: Do you understand my question?

MR. PAPAZOGLOU: Yes. What we did was the following. We assumed that Limerick belongs to a group of plants that have some sort of similar performance in terms of coming out with an initiating event but not

identical to them. Now, some of these plants that are actually operating were seeing differences in their performance. Some of them are better, some of them are worse. What we assumed is, Limerick is going to be -- what we used in this particular assessment was the average of all the plants. We did not assume that it was going to be as good as the best or as worse as the worst. There is a substantial amount of detail into how we have reached this revision.

MR. KERR: Your interpretation is that Limerick tended to use data that would lower the frequency of initiating events? Or interpret data at least in a way -- whereas yours was more nearly an average?

MR. PAPAZOGLOU: Let me try a specific example. In the loss of off-site power, we have a difference in the data base, first of all. The Limerick PRA assumed that data that comes from fossil plants had become routine in this case. We did not accept that. We used only the data from the nuclear power plants that belonged to the same reliability constant, if you want.

Furthermore, the way that we have treated this data statistically, if you wish, is not the one that assumes that all the plants are identical, and whatever information we get from each plant can be pooled

together and treated statistically. We have adopted the approach that was introduced in the Indian Point-Zion PRA.

I am not sure if I can be more specific without getting into technical detail.

MR. KERR: That is specific enough. Thank you. Please continue.

MR. CHELLIAH: Let's go on. This slide shows a summary of some of the dominant sequences for Limerick as well as for BNL's review. I would like to give you a couple of comments.

The first two sequences are the same. I don't know whether you can read this. This is loss of off-site power, followed by the failure of high pressure coolant injection as well as low pressure coolant injection. This amounts to somewhere around 42 percent of core damage frequency.

In the Limerick PRA, this is about 41 percent of their total core damage frequency. It is almost the same. Almost. The second dominant frequency that is in MISO closed valve followed by the failure of high pressure coolant injection, and the human failure of timely initiation of the aerator system, which is the same as here. There are about five other sequences. They don't really line up in order, but they are about

the same, really.

If you add up all these seven sequences, it is something like about 78 percent of the total core damage frequency. One interesting observation here is, all these seven dominant frequencies are of BNL's review. At least the same two functions. Here you see the U function and the other is the X function, here, here, here, and also here (indicating).

BNL has identified about 40 sequences which are less than about 1 percent, really. These are the general comments that you can arrive at out of these dominant accident sequences.

MR. MARK: Perhaps you made this clear, but I didn't catch it. Some of what you have there is the 1.1 $\times 10^{-4}$th roughly.

MR. CHELLIAH: That is three-quarters, yes.

MR. MARK: That is three times larger, approximately, than the estimates provided in the Limerick report. Is that due to differences across the board, a factor of ten on each, or is it mainly due to a difference in that bottom term or the bottom two terms?

MR. KERR: Do you understand the question?

MR. CHELLIAH: Yes. I don't have a breakdown on each sequence. All I can tell us that the U and the X are contributors to each sequence substantially, so

since they appear in at least four sequences, I think the uniformity is the same, yes. We haven't reviewed this. Of course, we will review BNL's report.

MR. THADANI: I would request Dr. Papazoglou to respond to that question.

MR. PAPAZOGLOU: The answer goes across the board. It is more or less uniform for the accident sequence, because of -- the main contributor, the main factors that bring about this difference are, as you said before, the initiating events which multiply all the accident sequences, the dependencies that are present in most of the accident sequences, and the changes in the system availabilities that appear in most of the frequencies.

So, without -- I don't want to say that it's -- what I'm going to say is mathematically correct or rigorous. Yes, it is across the board. It is a factor of ten in every accident sequence.

MR. MARK: It clearly has to be in the bottom event, because that bottom event by itself is four times the other value.

MR. PAPAZOGLOU: I am sorry. What is the bottom event?

MR. MARK: $T_E UV$.

MR. PAPAZOGLOU: Yes, it is more or less, if

we take each one of those sequences and we see how much higher frequency we predict than the Limerick PRA predicts, then I think this factor is more or less very narrowly distributed around the overall factors by which we overestimate the core melt frequency.

MR. KERR: This major Brookhaven error wasn't a systematic factor of ten all throughout, was it?

(General laughter.)

MR. THADANI: No, it wasn't. We will come to that later on.

MR. KERR: Was there something else?

MR. THADANI: Would you like to have some clarification of that error?

MR. KERR: I like mystery. We will get to it in due course.

MR. CHELLIAH: I will make a general comment that most dominant accident sequences are loss of off-site power followed by loss of coolant. The same in BNL's review and the Limerick PRA.

(Slide.)

MR. EBERSOLE: Let me ask for a clarification. You use core damage frequency and others use IP. Are you meaning the same thing?

MR. CHELLIAH: This is one of BNL's terms. Maybe Dr. Papazoglou can give you a better explanation

on this.

MR. PAPAZOGLOU: I guess Mr. Thadani wants to respond to that question.

(General laughter.)

MR. THADANI: At least based on our knowledge to date, we really have not been able to distinguish between core damage and core melt. In reality, the distinction is there, but in terms of these calculations, I would treat the term "core damage" as the way we have been using other places the term "core melt." It is the same sort of thing, recognzing that there might be some cases -- in fact, we know of cases where one could indeed have some core damage but prevent a large-scale melt.

MR. KERR: As it is used here, maybe it is too specialized. If so, say so. Would TMI 2 be core damage or core melt? Or would one in effect using the criteria used here call it a core melt?

MR. THADANI: I would give you my interpretation. Then perhaps Brookhaven can give you their thoughts on how they use the term. If indeed this were a PWR looking at a TMI 2 type of event, I would suspect it would be called core melt.

MR. PAPAZOGLOU: I agree.

MR. KERR: Thank you. Please continue.

MR. CHELLIAH: Dr. Kerr, my interpretation of core damage is more like a core vulnerable condition. If you want to go maybe probabilistically, maybe a core vulnerable to a core melt, you may be able to assign an additional probability.

MR. EBERSOLE: Could the distinguishing difference be that the core damage doesn't imply loss of the vessel? That is, it doesn't run off as a liquid and threaten the primary vessel?

MR. THADANI: Mr. Ebersole, I missed your point.

MR. EBERSOLE: Is the implication here that core damage is not a molten core that runs off and threatens the primary vessel and a core melt is?

MR. THADANI: As I indicated, the way these calculations are done, the criteria that are utilized, there really isn't any distinction.

MR. EBERSOLE: No distinction.

MR. CHELLIAH: Let's move on. This relative contribution of various initiating events to total core damage frequency, the dominant contributor is loss of off-site power, which is about 51 percent on BNL's review, and about 46 percent in the Limerick study. In this case, it is an isolation event. The LOCA contributes about less than 2 percent really.

(Slide.)

MR. KERR: Let's see. That says that in both cases, loss of off-site power contributed almost 50 percent of the total, so that if you did use different numbers for the frequency of loss of off-site power, that could represent a rather major difference, and then you said that you did use different loss of off-site power numbers than Limerick did. Continue, please.

MR. MARK: Could I ask, Bill --

MR. KERR: Yes, sir.

MR. MARK: -- in connection with loss of off-site power, one may follow that, and obviously the consequences could be great as to whether the diesels would start or not. Let's say the diesels start when you have lost off-site power. So what? If they don't start, you've lost off-site power and things are in a different state. We have heard that we have numbers for the failure to start diesels like 1 percent, 2 percent. That is failure to start in some specified time like ten seconds, but it really isn't necessary that they start in ten seconds in all cases of loss of off-site power.

How was that handled?

MR. KERR: Do you understand the question?

MR. CHELLIAH: Yes. If I understand your question, you would like to know what is the scenario

behind the particular accident sequence.

MR. MARK: Well, you have lost off-site power. That can be bad if the diesels don't start. It doesn't matter very much if they do. What criterion do you use to decide whether they are likely to start? You have a probability number you plug into your product to decide if the core melts or not.

MR. THADANI: Mr. Mark, I think if I understand your question, what sorts of data base was utilized in coming up with the unavailability of diesel generators for a certain length of time is the key, I think. That is what you are asking. Let me ask again Brookhaven to respond to your question by telling you about what sorts of data they looked at and how we utilized that information in these sequences.

MR. MARK: That gets to my question.

MR. PAPAZOGLOU: The way the loss of off-site power is handled is, you say one assumes that such an event occurs, that we lose off-site power. Then the next question is whether the diesels start or not. Then, if they start, there is no problem as far as the electric power is concerned. All the engineered safety features have to work, of course.

So, what we do then, when we are at the point where we have lost off-site power and the diesels do not

start, then we examine whether we can recover off-site power or the diesels. This part of the analysis has been time-phased, if you want, according to the requirements that are put on the engineered safety features. There is a whole event tree that treats this particular initiating event, loss of off-site power, that distinguishes between various design periods and whether some sort of power has been restored during each space.

MR. MARK: The requirements on the diesels, as I understand it, this may not be correct, is that if they fail to start in ten seconds, they are dead.

MR. KERR: Carson, I think he is saying he didn't treat that simplistically.

MR. PAPAZAGLOU: That's right.

MR. KERR: You treated it according to a specific sequence, I think.

MR. PAPAZOGLOU: It is not very much sequence-dependent, but there is a sequence of events there. If the assumption is the diesels don't start, the next question we ask is how soon they can start. Does it take a half an hour, one hour? Does it take two hours? What is the probability that they will start in each of those time intervals? And from the existing data, these probabilities have been assessed, and we

treat each particular sequence accordingly.

In other words, one sequence assumes the diesels are recovered within a half an hour. The other assumes the diesels are not recovered, but we think of an arbitrary number, one hour, and so on.

MR. MARK: Thank you.

MR. EBERSOLE: May I ask a question? Can you recall the first critical failure which was irreversible that led to core damage, at what point in time it occurred, and what it was? Did you lose core coolant, or did you lose ambient control, or what happened?

MR. PAPAZOGLOU: Well, for core damage, one has to lose the capability of injecting coolant into the core. That means that one has to lose both the high pressure injection system and the low pressure injection system. If -- the way that these two things were treated was -- there was no time allowed for recovery, if you want. At a certain point, we have lost all coolant injection capability. Then the assumption was that the core melt has been achieved. It is there.

MR. EBERSOLE: Yes. But high pressure injection is not dependent on AC power.

MR. PAPAZOGLOU: High pressure injection is not dependent, but the cooling of the high pressure injection pumps is dependent, at least two hours after

that.

MR. EBERSOLE: Thank you.

MR. CHELLIAH: I will add to that, if you don't have loss of off-site power, if you have lost all the diesel maybe due to some common mode failure, what happens is, you still have turbine-driven HPSI AC which will give you high pressure coolant injection. What happens in the Limerick plant, the HPSI room is cooled provided by non-class 1E power supplies, so you have lost that. Now the room is getting the heater up. The Limerick predicts it is about three to four hours. The pump may not be operational. That is the scenario really behind that sequence.

MR. EBERSOLE: Okay. I have got it. Thank you.

MR. OKRENT: With regard to loss of all AC power, is it the off-site power or the on-site power that one expects might be restored sooner, and whose restoration time then ends up being the driving force?

MR. CHELLIAH: Well, probabilistically, the Limerick PRA says you should be able to get power within four hours. Otherwise, you have some other battery you need for some other start and control --

MR. OKRENT: You are answering a different question. Let's say you have four hours. Do you have a

better chance of getting off-site power and on-site power back in the four hours, assuming you lost both in the beginning?

MR. THADANI: Dr. Okrent, at least based on some of the generic studies, I don't know specifically for Limerick, the data seems to indicate that there is a much greater likelihood of recovering off-site power than on-site power.

MR. OKRENT: Okay. That leads, then, to a second question.

MR. KERR: The other answer would have, too, wouldn't it?

MR. OKRENT: No.

(General laughter.)

MR. OKRENT: Your estimates of the likelihood of restoring off-site power are based on experience with the loss of off-site power and the time to restoration in the past, I assume.

MR. THADANI: That is correct.

MR. OKRENT: To what extent does the experience depend on the rolling reserve or the backup capability? Is that an important factor, in your opinion?

MR. THADANI: Dr. Okrent, again, I believe that that does play a major part, but I don't recollect

various estimates, but I do know that for different regions, the likelihood of recovering off-site power to the pump as a function of time, there are some differences, and in some cases the differences are quite significant.

MR. OKRENT: Let me get to the question then. I read that in the future utilities may for one reason or another be running with less reserve capacity than they have had in past years, partly because public utility commissions might want to keep rates down and say, do this, don't kill the plants, or whatever.

I am just wondering whether that has been factored into your estimates. At least let me leave it as a thought for the experts on off-site power restoration frequency, okay? It does not have to be answered today.

MR. CHELLIAH: Well, a general comment is, BNL may use PJM reliability data.

MR. EBERSOLE: Mr. Chairman, let me ask a question. The revelation that it was ambient temperatures in the HPCI and RCI rooms that shut them down and caused trouble leads to the next question. This is an old boiler, and these are steam turbine pumps, steam turbine-driven pumps. There are trip circuits based on rising ambient temperature which are anxious to close off steam flow as ambients rise on the thesis that they have broken pipes.

This is an old topic. I hate to bring it up again. But rising ambients automatically produce a short-term effect right away of closing steam flow to the turbines in a common-mode way. Did you find that this plant had been cleansed of its deficiency and that that did not hurt?

MR. CHELLIAH: I am not aware of such, Dr. Ebersole.

MR. EBERSOLE: Is there anybody here that knows that?

MR. PAPAZOGLOU: We are not ready to answer this question specifically, but I would like to make a comment on that. There is in the context of the PRA a whole issue of cooling the high-pressure injection pumps. It is treated as a required action by the operator. There is a point in, I think, 2 hours after

the loss of off-site power, loss of cooling, if you want, in which the operator has to go down and open a couple of doors to provide some alternative natural circulation cooling.

Now, although this particular problem that you raised -- and unfortunately, we do not have the right person here; we may not have that included in the fault tree -- I am sure that that quantitatively is somehow included in the probability that the operator will perform whatever actions are necessary to establish some alternative for these high-pressure --

MR. EBERSOLE: He can override the closing function; is that what you are telling me?

MR. PAPAZOGLOU: I am not sure. I would also like to comment on Dr. Okrent's question on the loss of off-site power. The loss-of-off-site power event, as it appears up in these charts and elsewhere in the study, is mainly due to events that result in loss of off-site power for the particular plant because of some sort of circuit breaker opening or a line loss. It's not really loss of the grid in such a situation, as the question as the spinning reserve and the grid stability would be pertinent.

We have treated that in a different way. Given every and each initiator or initiating event, we

have assumed that the charge to this grid stability and there is a chance that due to this charging we lose the grid and that would result in a loss of off-site power, which we think is somehow qualitatively different than the other losses of off-site power and would take much more time to restore and would be a much more severe event.

Now, the probability of losing the grid because of getting out the grid was $10^{-3}$ that was also assumed in WASH-1400. Whether this is coupled to the present state of the particular grid or whether it will be still applicable 5 years from now when the grid reserve is going to be much less, is a very valid question.

MR. EBERSOLE: Bill, may I ask one more? Is this plant not characterized by minimum tie-up to off-site? How many lines are outgoing and incoming?

MR. PAPAZOGLOU: They have, I believe, a total of five lines.

MR. EBERSOLE: It's well intertied?

MR. PAPAZOGLOU: Yes.

MR. KERR: Please continue. By the way, my plans are to recess for lunch at 12:30.

(Slide.)

MR. CHELLIAH: This slide shows the

distribution of core damage frequency among various classes of accident. According to the Limerick PRA, each class is a group of accident sequences which are characterized by the containment's physical condition and how rapidly the core is damaged.

Class I is some of the transients that you get involved: loss of coolant inventory, this involves loss of heat removal capability from the containment (indicating). Here the containment fails before the coremelt, this particular one.

The Class III and IV, they are the same as Class I and II except it is initiated by no scram event. The BNL review indicated that even though this Class I is dominant in core damage frequency, this particular one and this one (indicating) are very high risk contributors.

Also, this particular slide shows how it compares with the WASH-1400 value. They estimate the mean value that's the Limerick total value. As you see here, the increase in each class due to the BNL's review is also an order of magnitude.

MR. KERR: Question. If I recall correctly, in the Limerick PRA they included a feature whereby if you got into a situation where you were starting to overheat the containment, you could vent, assuming there

had been no fuel failure; that then reduced the likelihood of getting into difficulty from your Class II event there.

MR. CHELLIAH: If I recall, Dr. Okrent, the Limerick PRA Revision 2 had a containment water pressure relief system. The applicant removed that system in quantifying these sequences.

MR. KERR: I see.

MR. CHELLIAH: That system doesn't exist in Revision 4.

MR. KERR: That was my question. So these would be the results if they did not have this containment vent feature, whatever it was called?

MR. CHELLIAH: Yes.

MR. KERR: Has the Staff reviewed that containment vent feature at all? And why did they remove it in Revision 4?

MR. CHELLIAH: BNL reviewed the impact of the removal of the system. They tell you what is the impact on risk.

MR. THADANI: Dr. Okrent, while Mr. Chelliah is looking --

MR. CHELLIAH: I have the result.

MR. THADANI: The Staff has not reviewed the Limerick PRA. The Staff has not arrived at any

conclusions at all regarding the Limerick PRA and the role of the containment overpressure recirc system. The applicant initially considered the system; subsequently, he reanalyzed without the overpressure relief system, and Mr. Chelliah can tell you what the applicant said in terms of the effect of removing that system on their study.

MR. CHELLIAH: Yes. BNL reviewed this particular assumption regarding the removal of the overpressure relief system. They performed some sensitivity studies. The result is if you include the containment overpressure relief system, the total core damage frequency will drop by 13 percent. That is primarily due to this particular Class II sequence frequency.

The fatality goes down 18 percent. The latent fatality goes down by 6 percent. This particular sensitivity is based on the Limerick PRA normalized mean fatality values.

MR. KERR: Let me assume for purposes of discussion that those are good numbers and everybody who reviewed it would arrive at the same numbers. Are those significant changes or not? How do you decide?

MR. CHELLIAH: Oh, as Mr. Thadani said, we are in the process of reviewing this, and we will report our

evaluation of this particular BNL review.

MR. KERR: Do you not decide whether a number is significant until you completed your review? It seems to me you need to have some preconception of what is important and what is not before you start the review.

MR. THADANI: Dr. Okrent -- pardon me, Dr. Kerr. Clearly, the process one has to go through is to look at when is containment overpressure relief systems are important in their other aspects. I think there are several other apsects to see what the impact of various considerations might be on the estimated coremelt frequency and public risk. This is one feature which makes the 10 percent or so impact on coremelt frequency or an 18 percent impact.

This does seem fairly important. But I think one cannot just look at it in isolation. One has to look at what else one might consider in the implications of the other things to be considered.

As I indicated earlier to you, once we get to a point where we have a reasonable degree of confidence that the study is fairly complete and so on, we would be looking at what the dominating risk is, how does the risk compare with the risks at other sites. In this case the earlier management decision was to compare it to Peach Bottom and then to also bring in thoughts on

value impact. 10 percent at this stage seems reasonably important. I don't know that it is very significant, but it seems reasonably important.

MR. KERR: Well, if one follows what I understand to be the safety goal, 10 percent or 18 percent would be significant only if it were near to or bigger than the fatalities early or late which are goals or quantitative guidelines. If 18 percent were below that, one might eliminate it, but one would now go on to an ALARA calculation to determine what to do about it.

MR. THADANI: That's what I was saying. That's what I meant when I said value impact, that it would be that kind of a consideration.

MR. KERR: But value impact consideration arises only if you were below the quantitative guidelines for risk, I think.

MR. THADANI: Are you saying that if it is $10^{-4}$ versus $1.1 \times 10^{-4}$ ?

MR. KERR: I am saying all we have said is an 18 percent contribution, whatever the probability of coremelt is, I don't know what relationship there is with coremelt and risk which are part of the guidelines if one finally adopts that approach.

Let's suppose that the ultimate risk is below the guidelines and is 18 percent of something that is

within the guidelines. My interpretation of the approach of the safety goal is that one would not automatically correct the 18 percent even though it's a big fraction of the total, the total below those guidelines. One would now look and say, does it fall within the ALARA criteria, whatever they finally are. Either we will do something about it or we won't do something about it, based on that determination and not on the fact that it's 18 percent.

MR. THADANI: That's exactly what I am saying also, that if you're below the guideline, indeed we would look at it with that perspective.

MR. KERR: Okay.

MR. OKRENT: May I ask a couple of questions related to this? I think you used the term something like -- I am probably paraphrasing -- when you decide that this PRA is adequate, then you will complete your decision-making process. Am I correct?

MR. THADANI: I am saying that unless something just sticks out there that says we should take some action.

MR. OKRENT: Oh, yes. As was noted earlier, there were several initiators not included in the original PRA. Do they need to be included before you can do your decision making or so-called external events

and perhaps other things?

MR. THADANI: My reaction would be that at least in the short term that is unavoidable. If that's the information we have.

MR. OKRENT: What is unavoidable?

MR. THADANI: We do not have quantitative risk assessments of external events for this site. So whatever decisions the Staff is going to make are going to have to be based on -- that is, whatever decisions the Staff makes which are influenced by the PRA would have to be limited in this case to the internal events.

MR. OKRENT: Let me explore that a bit. Assuming you found a terrible outlyer and something came out so large that Mr. Denton had to act one way or the other, that would occur. So let's put those aside. All right. Now, for example, a moment ago there was a question raised in a discussion between you and Dr. Kerr, well, suppose you are below the safety goal and there is an initiator which could be reduced by a certain amount, what does one do or not? How do you know if you are below the safety goal and you are missing several, let's say, well-identified initiators?

Furthermore, there are various things that are not included in any of the current PRAs. So how do you make your decisions unless there are these clear

outlyers on which you know you have to act?

MR. THADANI: I think you have to make decisions and recognize that your knowledge is not as complete as you would like it to be.

MR. OKRENT: Well, what are we going to tell the people in Pennsylvania? We have an incomplete study and the risk is, after they make this change in the procedure and they have recalculated this, we now come out with these initial initiators at $9 \times 10^{-5}$, this is less than $10^{-4}$, we are going to apply ALARA, use $1,000 per man-rem, everything else, or just what?

If you don't do that, then how do you allow for the missing initiators, the missing contributors in the middle?

MR. THADANI: No. I think I would perhaps change the emphasis somewhat. The emphasis has got to be placed on the determining of the licensing basis and the regulations and the criteria that are developed. All you have here is yet some more information which is helping you identify potential vulnerabilities at the plant which may be well beyond what the plant was designed for. Similar factors would indeed apply in terms of external events.

But as you yourself pointed out earlier, Sandia's report was pretty strong in the sense that they

didn't say what the risk from external events were for Indian Point. They said, if we take the licensee's analysis and their estimates, we would revise those estimates by the following factors. There is a considerable amount of controversy, of which you are familiar, as to how reliable these estimates are, especially when they come to these external events.

As far as Limerick is concerned, it was the Staff's judgment that these methods were just not mature enough, that it is more useful to try to learn about the plant, and from that judgment obviously we got the results from the reactor safety study.

Here the intent was to see, well, is there something that we can analyze with the methods that we know of today and are there any reasonable actions one could take to improve the safety of the plant? But I don't think one can say that there isn't a potential of the external events being dominant in terms of their contribution. It's the question of reliance on deterministic criteria.

MR. OKRENT: Well, I must say that it is a little bit bizarre that had the applicant at Indian Point chosen to follow the path that the Staff in its infinite wisdom was the right path for doing the PRA; namely, analyzing for external events.

MR. KERR: Is it all right if we strike "infinite wisdom"?

MR. OKRENT: He would have been computing numbers smaller than $10^{-4}$, if I remember correctly for the internal events, and it would be a rather different ballgame. I guess I am trying to understand whether the Staff proposes to proceed with Limerick and not bring in external events or just what it is and why the Staff thinks this is the right way to proceed?

MR. KERR: That's not a question. He said he is wondering.

Is that a question?

MR. OKRENT: Are they going to include external events? If not, why?

MR. KERR: We have a question. Are you going to include external events?

MR. THADANI: At this stage, there is no intent to include external events.

MR. OKRENT: Well, I will offer an opinion. I won't be able myself to understand how you are going to arrive at a judgment concerning a whole host of things except for something that just stands out that must be corrected.

MR. EBERSOLE: What is the basis for that, may I ask? Is it that it is too nasty a thing to consider

or it's not important?

MR. THADANI: Mr. Ebersole, I hope it is clear, and I will speak for myself, but the question is not that it's too nasty to consider. I think the question is that of methodology, whether one can reasonably estimate risks from these external hazards where the information base is very limited. As I said, at this stage, I know of no Staff plans to require treatment of external events.

MR. EBERSOLE: Is there a reason for that?

MR. THADANI: It's conceivable that once the Staff develops some level of confidence that these techniques can reasonably be defined and develop some methods essential assumptions and so on that could well be applied, the decision might well be quite different. I am talking about today, at this stage, we just have more questions about how to analyze these events than we have answers.

MR. KERR: Let me say I think we ought to be a little careful about the nomenclature we are using. It's not quite accurate to say that the Staff is not considering external events. They certainly are in the licensing process. They are not analyzing external events using the PRA. But even if they did, it is not clear what they could do about it with existing

regulation.

MR. EBERSOLE: Well, the Indian Point analysis included it.

MR. KERR: The Indian Point analysis included it, but I asked the question: Suppose that the Indian Point analysis shows that the risk is unacceptably high but the plant meets all existing regulations? And the answer I got was: The Staff didn't know what it was going to do if that was the circumstance that turned out to be the case.

Now, suppose you do this for Limerick, you do the PRA, and it turns out the risk is high. I don't know on what basis. But the plant meets all existing licensing criteria. What do you do? You meet the existing regulations, you follow the regulations? Or do you change your regulations so that they include PRA? The existing regulations do not include PRA.

MR. EBERSOLE: I guess this is the first PRA I have heard of that has studiously excluded external events.

MR. OKRENT: No. To the contrary, only really Zion and Indian Point made a fairly systematic attempt, although there have been some minor attempts by others.

MR. EBERSOLE: At Zion it was a predominant factor, wasn't it, the seismic aspect?

MR. OKRENT: As estimated in the licensee's submittal. There are other submittals that find other contributors.

MR. SCHWENCER: Al Schwencer from the Staff. I would like to make a comment on how the scheduling of the PRA is going for Limerick in terms of the overall Staff review. There have been a couple of items identified, the potential for a temperature in a room adversely affecting components and the question of being able to vent to prevent an overpressure. Earlier at Indian Point the comment was raised related to these various matters. So as we identify items that could potentially impact these, these could be candidates for a more in-depth review by the Staff in its complete licensing review.

I would fully expect that I have got some notes on this temperature problem. It's similar to Brunswick and other areas. So we would want to check and see whether this can reasonably be done in the case of taking a concern to the applicant, not necessarily waiting for an answer.

MR. KERR: I would point out that if this is what you are using it for, you certainly do not have to use a full-fledged PRA. You can identify things that if they got too hot wouldn't operate, without doing a PRA.

This may be a fallout of PRA.

MR. SCHENCER: I would expect that the temperature problem in Appendix R would have been picked up in the normal course of the review. The overpressurization, the Staff is already looking at that in terms of emergency procedures for Staff. So that is being picked up. I just pick them as examples. The Staff is going to catch those specific things anyway.

MR. KERR: I didn't say "would." I said "could." It certainly is no criticism of the Staff, I think, to say it cannot review everything, every item in detail. My point was that one does not have to go through a full-fledged PRA to catch that sort of thing.

Mr. Okrent.

MR. OKRENT: I think Mr. Thadani indicated a problem with the availability of methodology for analyzing the so-called external events, and that was the basis for not doing it at Limerick. While I certainly would not by any means argue that there exists a very good methodology, nevertheless there is a methodology that has been applied to Zion and Indian Point for fires, for earthquakes, and for wind. In fact, if I can recall the discussion earlier this morning, the Staff thinks as a result of some of these things it should take some steps or at least it is

talking to the licensee about some steps on seismic and it has gotten Mr. Denton thinking about should it do something about things and when.

So I have this curious situation on the one hand where there is no methodology for Limerick, on the other hand we have some results for Indian Point that are the basis for not just more studies but really short-term kinds of action.

Am I missing something?

MR. KERR: We could carry on our debate later on. But I would certainly, if I were the applicant, like to have some idea of what the Staff is going to do with the results of one of these things before I spent the manpower and effort that is necessary.

It is one thing to carry out a study to look at some criteria that have been established you know what you are trying to determine; it's another thing to say, go carry out a study, we will certainly decide what to do with it after we have got it. That is sort of what Limerick was faced with, it seems to me. It sort of makes it an experimental thing, and maybe one or two of these things isn't bad, but at some point somebody needs to decide what are the criteria that are going to be used in the decision-making mode once we have gone through this exercise.

MR. OKRENT: I agree with that. In fact, the study of a kind has been done for Limerick, and there is a lot of effort being spent to review it, and we are in the middle of this. And the Staff seems to think it's going to somehow make decisions with what I would call an incomplete perspective. As just one example, the design-basis earthquake for Limerick, if I recall, is .15 g. Now, it may turn out that there is lots of capacity everywhere in that plant to take less frequent earthquakes than that but --

MR. KERR: On the other hand, we have to remember that something cracked the Liberty Bell at some point.

MR. BENDER: It was quality assurance.

MR. OKRENT: I am not sure --

MR. KERR: Would you agree to a 1-hour recess for lunch at this point?

MR. OKRENT: That would be fine.

MR. KERR: I declare a 1-hour recess.

(Whereupon, at 12:40 p.m., the meeting was recessed, to reconvene at 1:40 p.m., this same day.)

AFTERNOON SESSION

(1:45 p.m.)

MR. CHELLIAH: Good afternoon. This is where we were when we went on the break. The last comment I wanted to make on the slide, for Class III and IV sequences, the Limerick applicant assumed an Alternate III-A ATWS fix and quantified all these sequences. BNL reviewed that particular aspect, and they did some sensitivity analysis. We have some results I will give to you.

This Alternate III-A includes about three or four fixes; if you recall, a recent pump trip and some scram instrument volume; there are three auxiliary pumps which will provide 120 gpm. BNL made some sensitity analyses of what would be the risk benefit if you add another pump. We have some results. We will give them to you.

If you add another pump, some of these sequences, you have a frequency and will get something like a 20 percent reduction on latent fatalities, about a 5 percent reduction.

I think that is all I have on this slide. Are there any other questions on this?

(No response.)

(Slide.)

This slide gives some of the --

MR. KERR: Excuse me. If I try to draw a conclusion from the graph presentation --

MR. CHELLIAH: The previous one?

MR. KERR: -- should I conclude that ATWS is no longer a concern or that ATWS is still a concern because of conclusions that have been reached?

MR. CHELLIAH: Well, by looking into BNL's latent fatality calculation, although you have an alternate fix, still this particular sequence gives a higher contribution to the early fatalities. You will see that in BNL's draft NUREG report.

MR. THADANI: Dr. Kerr, what Mr. Chelliah is doing is presenting to you results of the assessment. Whether that is necessary or sufficient as far as ATWS is concerned is being considered separately. The point of Mr. Chelliah's presentation here really is that on Limerick they have implemented what used to be characterized as Alternate III-A and with that system in place here is how the risk might look like from ATWS.

MR. CHELLIAH: That's right.

MR. KERR: Well, that says frequency of coremelt per reactor-year. He also mentioned comments about risk. And one could conclude, I think, that the contribution to frequency of coremelt is, what, $10^{-7}$,

thereabouts?

MR. THADANI: No. About $10^{-5}$, Dr. Kerr.

MR. KERR: Is the whole thing ATWS? I thought ATWS was -- well, tell me what fraction ATWS is.

MR. THADANI: Essentially all of it is ATWS in those two classes.

MR. CHELLIAH: We have these two alternates that come to $1.1 \times 10^{-5}$.

MR. KERR: Then I don't understand that.

MR. THADANI: If I may just simplify, the total coremelt frequency as estimated by BNL is about $10^{-4}$ [illegible] Limerick, and their estimate of ATWS fr[illegible]cy leading to coremelt is about $10^{-5}$. And the distinction is that there are different classes of releases and the ATWS events happen to fall in what we will call Class III and Class IV types of releases.

MR. KERR: Does the bar graph there represent the Limerick calculation or the BNL calculation?

MR. CHELLIAH: This represents the PRA. The whole thing represents BNL's review. So the unshaded area is really the increase due to three major items which I pointed out in the first slide. The support system redundancy --

MR. KERR: BNL would conclude that within Class III there is $10^{-5}$ contribution. And how much of

that was ATWS? All of it?

MR. CHELLIAH: This increase --

MR. THADANI: The answer is yes, Dr. Kerr.

MR. KERR: Since the other is less than $10^{-6}$, the contribution is about $10^{-5}$.

MR. SEIDENSTICKER: It is 10 percent either way.

MR. CHELLIAH: I would note this Class IV combined with the three containment failure modes gives a significant risk.

MR. KERR: Gives what?

MR. CHELLIAH: I will repeat this. The Class IV sequence when it combines with the three containment failure modes will give you a higher release and thus a consequence.

MR. KERR: Okay. I understand that. Continue, please.

(Slide.)

MR. EBERSOLE: Just one second. Before you get away, is that because ATWS is likely to be a sudden thing?

MR. CHELLIAH: Are you referring to this?

MR. EBERSOLE: Right. And therefore, evacuation procedures are not effective?

MR. CHELLIAH: This particular sequence, the

pool temperature rises very quickly, so you have a containment failure, so there is rapid core damage.

MR. EBERSOLE: What I am saying is, does it account for the fact that evacuation procedures are not effective for that kind of containment failure since it is so sudden?

MR. THADANI: Yes, Mr. Ebersole. That is an important consideration.

MR. OKRENT: But how early is early?

MR. THADANI: I will ask Dr. Pratt to respond to that. I don't recall the time.

(Pause.)

MR. PRATT: My name is Pratt from Brookhaven. This kind of accident sequence we are talking about failing the containment building in about .7 of an hour. The coremelt occurs after failure of the containment building in about 1.2 hours. And that does not give you much time for evacuation; that is correct. The correct calculations would reflect that lack of time.

MR. EBERSOLE: When you weight this result against this probabilistic arrangement here, does it not turn out that the ATWS is the predominant hazard?

MR. PRATT: It is extremely important. It dominates the acute fatalities simply because for the Class I sequence we don't predict any acute fatalities.

So although the probability is much lower, it is the major contributor too. To the latent fatalities it has a greater impact.

MR. MARK: You make a reference to the CRAC calculation. Is that the same ridiculous thing that was used in the reactor safety study?

MR. PRATT: Yes.

(Laughter.)

MR. MARK: They had them evacuating downwind along with the cloud so they could keep up with it and so forth.

MR. ACHARYA: My name is Sarbes Acharya, from NRR. The Staff is using the CRAC Code for the site-specific application. This was different from that that was used in the RSS. We can account for the delay time before evacuation and also the speed, each of which would have been assessed by considering the road network.

MR. MARK: I am particularly anxious that such a code should allow for the possibility that if a cloud is coming from the west that a person might have enough sense to walk north instead of east.

MR. ACHARYA: What we say doesn't assume that the individual is following a cloud. However, it does assume that the trajectory of the individual moving might pass an active segment of the cloud movement.

MR. KERR: Please continue.

(Slide.)

MR. CHELLIAH: Moving on to the containment response analysis areas. BNL includes some sensitivity analysis of some of these items. In performing the sensitivity analyses, BNL used Limerick PRA frequency and Limerick PRA normalized to the mean fatality values. Using those two, BNL started reviewing the appropriate containment event trees. They quantified the risk against a value of a factor of 2 increase and a 1.7 percent increase in the mean. This turns out to be, according to BNL, very conservative. Also, this one (indicating).

MR. KERR: How does one remove pool flashing at containment failure?

MR. CHELLIAH: Dr. Pratt will explain that.

MR. PRATT: Let me explain a little bit what we did up here. Case 1 there, the first item is really a sensitivity study that we carried out looking simply at the containment event trees. What we did, we accepted the frequency of the damage dates in the PRA and also the consequence analysis in the PRA and just simply looked at the appropriateness of the branch point split fractions in the event trees.

So those are the type of value changes you

will get resulting from some of our concerns with the trees. The main contributor there was that we felt that the containment event trees were applied to all classes of accident sequences where two of the classes, Class II and Class IV, were actually a failed containment prior to core meltdown.

We felt that the probability of the steam explosion, which was given as being the combined probability of not only the steam explosion occurring but also failing the containment building as well, was somewhat low because the building was already failed and one only had to consider the probability of the steam explosion occurring. It was not necessary for that explosion also to fail the containment building.

So that increase is a mixture of a number of things. That is one of the concerns that we had, and that impacted acute fatalities significantly.

We were also concerned that the trees gave a 50-50 split to a leakage of the containment building as opposed to an overpressurization value. So what we did was we looked at the sensitivity, assuming that there was a catastrophic failure 100 percent of the time rather than 50 percent of the time. That had an impact mostly on the mean latent fatalities because it impacted the category that was dominated by the latent fatalities

and it didn't have any acute fatalities, so there was very little impact on acute in that assumption.

We also looked at the appropriateness of assuming the variousfailure positions. In the PRA there were assumptions made about where the crack would occur in the wall, whether it would be in the drywell, whether it was in the wetwell; if it was in the wetwell, would the suppression pool drain. So we did some pretty bad things there in moving around those probabilities. Again, we got an impact mostly on the acute fatalities and some impact on the mean acutes.

Now, in the actual report we have listed the limiting -- excuse me -- the limiting value of those assumptions. What is up there is a compound value which is our, if you like, best shot. So we looked at each of those concerns individually and measured the impact on risk individually; then we put the whole thing together as what we have considered to be a best estimate, if you like. And those are the changes we would get.

MR. KERR: Let me repeat my question. How does one remove pool flashing at containment failure?

MR. PRATT: That is number 2, I guess. Number 2 for Class I sequences, the assumption was made that at containment failure the suppression pool would flash. This is in spite of the fact that the pool was

calculated to be subcooled, not only by ourselves but in the Limerick PRA. We didn't see how by depressurizing the containment building and bringing the pressure down from 144 to atmosphere when the pool was way subcooled, that it would flash. So we felt that was a very large conservatism in the calculation.

We only did it for Class I sequences because that's the only one where the pool was subcooled. The reason why it only impacts latent fatalities and not acute fatalities is because for Class I sequences there are no acute fatalities predicted for the class. So it impacts latents only.

MR. MARK: I have what I think are two questions. You have factors of 2 and 3 in the estimates of fatalities. You have a factor of 10 very nearly, 7 anyway, in the estimate of core damage frequency. Is the BNL study then using a different set of assumptions about the effects of a given release or the amount of the release or what? Because if you had the same release versus effects, you would have a factor of 10 showing up here instead of 2 or 3.

MR. PRATT: No. Ten is the frequency of the occurrence of the accident sequence. This is then just the probability, if you like, of a certain containment failure mode occurring given their consequence analysis. We then went on and did our estimate of what the release fractions would look like in certain cases, and that is Item 2 there. We actually got a reduction in consequences by a factor of 3, so that you stop and multiply the thing throughout, you get an increase of a factor of 10 for the probability, perhaps an increase of a factor of 2 for latent fatalities due to the changing of the containment event trees, but then you divide by 3 because of the conservatisms in the source term.

MR. MARK: So you really change the approach at that point instead of following the Limerick or the RSS approaches.

The other question, what are you using to correlate exposure and latent fatalities? Are you doing BEIR-II, BEIR-III or some 1945 estimate?

MR. PRATT: No.

MR. ACHARYA: This is the central estimate for RSS in the CRAC. The central model is not applied to the breast cancer.

MR. MARK: So you pay no attention to the BEIR report?

MR. ACHARYA: We have calculated -- some sensitivity analysis has been done by the Staff. If one does calculate it on the organ basis, as is done in RSS, the total latent cancer fatality resulting therefrom is almost the same as using the BEIR.

MR. MARK: The same as using BEIR-III?

MR. ACHARYA: Yes.

MR. MARK: There is no possible way of using BEIR-III. There are six different estimates in there. There is the majority report, the Chairman's report, the minority report, and there are two other ways of reading them, on either an absolute or relative basis. There isn't a number you can get out of that.

MR. KERR: That is not a question; it's a statement.

MR. MARK: You said they use BEIR-III.

MR. ACHARYA: I didn't say we used BEIR-III. If one would do some sensitivity analyses -- let me repeat this again. In the central estimate model of WASH-1400, which was some adjustment to the BEIR-II on the basis of a low dose rate and low delivered dose, this model doesn't have the cancers. They are in WASH-1400. This is a plateau of the plateaus used, and besides that, the risk calculations were on the organ basis instead of the whole body basis of BEIR-II.

Now, if one uses [illegible] model that has already been calculated into the CRAC, then one won't get the same number from the latent cancer fatality by using -- some study has been done, some calculations have been done by our research contracts that are going on at Harvard University, and the equivalent results resulting from here, the CRAC model and the BEIR-III, I cannot provide more details.

MR. MARK: In effect, the numbers come from --

MR. KERR: Did you hear Harvard? You can't argue with that.

MR. MARK: In effect, the numbers coming from using the RSS calculation you have compared with BEIR-III or at least one of the six options you have in BEIR-III and find that it fits one of those.

MR. KERR: That is not a question; that is a statement.

Other questions? Mr. Ebersole?

MR. EBERSOLE: Yes. May I ask a question about Item 2 up there? I guess I didn't understand what it meant. But the thing I am curious about, when you experienced containment failure in this design, was it automatic that you lost pump suction and therefore proceeded to core melt at that point if you hadn't already?

MR. KERR: Do you understand the question?

MR. CHELLIAH: Could you repeat the question?

MR. EBERSOLE: On containment failure, was this design so configured that you needed the containment overpressure of the uncondensable? The early BWR designs had to have that. I don't know whether this vintage had fixed it or not.

MR. CHELLIAH: This particular item, we are talking about core melt in a containment. In other words --

MR. KERR: I think his question is more specific.

MR. EBERSOLE: My question is merely: When you fail the containment, do you assume pump suction?

MR. PAPAZOGLOU: Yes. The assumption for the PRA calculations was once you lose containment, that means core melt.

MR. EBERSOLE: Thank you.

MR. KERR: Other questions before he proceeds?

[No response.]

MR. KERR: Please proceed.

MR. CHELLIAH: The important point of this presentation of the slide is BNL review of containment response analysis included many areas grouped into four categories here, four major items. You can see that it

nullifies the effect. This is the observation one can get, really, out of BNL's view of containment response analysis.

MR. KERR: What does one observe? You say the conservatism cancels out the nonconservatism?

MR. CHELLIAH: Yes.

MR. KERR: I wouldn't know that from the slide. How would one conclude that from the slide? I will accept your word that that is true, but I don't understand how one concludes that from the slide.

MR. CHELLIAH: Maybe Dr. Pratt can explain the conservatism in Item 2 and 4.

MR. KERR: Just from that slide you couldn't conclude that, could you?

MR. PRATT: I think the slide is a little bit busy. Perhaps it should be broken up and gone through in somewhat steps, which would have shown it a little better. I think Case 1 is really something that we did in the report in Chapter 6 of our draft report. The other items there, 2, 3 and 4, were developed in Chapter 7. There we are really talking about the way that the core meltdown phenomenology, containment failure would impact the release fractions and what impact that would have on the consequence analysis.

I think Point 2 is really the important one in

the sense that our best shot, if you like, would be that we would reduce the consequences because of this nonconservatism by a factor of 3. Then what we did was to say that, all right, there is uncertainty about that, and the other analysis we did in the rest of Chapter 7 was really summarizing the last two points, which was an assessment of the upper and lower bounds.

Point number 3, if you like, represents an upper bound because there we are looking at the sensitivity of the deposition model in CORRAL in terms of plate-out of the aerosols and so forth. And also it is not just that but it is looking at alternative core meltdown sequences that might result in early failure of the containment building. We considered that that would increase the latent fatalities by about a factor of 3, and that tended to be our upper bound in terms of uncertainty in terms of direction.

In the downward direction, PICO came in with a somewhat different picture as to how the core melt might progress rather late into our review of the PRA, and what I tried to do in Chapter 7 was to paraphrase their new position. It was essentially something that would replace Appendix H of the PRA and it would be a new sequence of how the core would melt down.

If you go with this new description, it would

reduce risk on the Category 1 latent fatalities by about a factor of 300. So there is an extremely large potential for risk reduction.

MR. KERR: You said that modal walked in off the street or something?

MR. PRATT: It . rather late in the review at a meeting between the staff and --

MR. KERR: Does it have any basis in physical reality?

MR. PRATT: It is another Bob Henry special, I guess. What they are postulating is that instead of the core material being distributed across the diaphragm floor, remaining there producing a lot of noncondensable gases and failing the containment building after two or three hours, after it gets through the vessel, that indeed a good portion of it would get through holes in the floor, would drop into the suppression pool, would quench in the suppression pool, form a coolable debris bed wih particles of just the right size so that they would not dry out. So there is no potential at that time for overpressurization. Steam explosions are a real possibility, so you have to sit around and wait until the heat is generated. That is an extremely long time.

Our calculations indicated --

MR. KERR: Did you try this model just because it was new, or did you have some reason to think it was superior to earlier models, or is that in the report?

MR. PRATT: It is in the report, and indeed, that forms our lowar bound calculation. It remains, I believe -- the documentation is now in, and correct me if I am wrong, which does document that new position.

MR. KERR: Does document mean describe?

MR. PRATT: Yes.

MR. KERR: Or justify?

MR. PRATT: Justify ahd describe, I would hope. We have to reviaw that. As I say, that has just arrived. What I did in that PRA was my understanding of what I thought they were talking about in the meeting. In the final report, we will have the benefit of studying that documentation and, I hope, doing a better analysis.

MR. KERR: Thank you.

MR. CHELLIAH: This PRA is Revision 4. Recently we have received Revision 5. We haven't looked into it but we are going to.

[Slide]

Now I would like to give a summary of BNL's findings on the core damage frequencies higher than Limerick PRA, higher than WASH-1400 by a factor of about

3 higher. The most dominant accident sequence is loss of offsite power, followed by the failure of high pressure and low pressure coolant injection. The contribution to the total core damage frequency is about 42 percent.

These (indicating) are the two items which are common to all those seven dominant sequences that I previously showed you. The risk statement says -- in your handout I have put it down. I would like to say here recently, about yesterday, we received some comment regarding the BNL review. Perhaps I would like to get Dr. Trevor Pratt to comment on that.

MR. PRATT: Trevor Pratt from Brookhaven.

I guess this is where your suspense is all broken in terms of the major BNL error. The error crept into the site model, to the CRAC calculation. In order to compare our results with the Limerick PRA, what comes out of the CRAC code for the latent fatalities is integrated over 30 years, and to put it on a 30-year basis, one divides by 30. We unfortunately also did that with the acutes, which is incorrect. So that the acutes that are reported in our report are a factor of 30 low.

The reason we did not pick up this error is that I think when we were comparing the results with the

Limerick PRA, the comparison was fairly good between our CRAC analysis and theirs. We were about a factor of 3 higher on latent fatalities. We had about the same ratio on acutes. What we are really saying now is there is a significant difference, factors of between 10 and 100, between our prediction of acute fatalities relative to theirs.

Now, in terms of the impact that that has on the report, let me put it into perspactive. We did not review the site model. The site model will be reviewed and is the respondibility of the Accident Evaluation Branch at NRC. We tended to use the CRAC Code really as a way of giving us a measure of how our changes or our perception of how the containment may fail, the phenomenology of core melt would impact risk. So we have tended to talk in terms of relative changes, which is what we talked about on the previous Vu-graph. That remains unchanged.

The latent fatality calculations in the report are correct. The containment evaluation is fine. The only thing that is of concern is when we come to the bottom line risk, and when we do compare directly the estimate of acute fatalities with those in the Limerick PRA, there are now significant differences. This is under very close review at the NRC, and as part of our

final report, we would have the benefit, I believe, of that review, so that the bottom line risk calculations that we come up with should reflect that review in the final report. So that there will be some changes.

What we have attempted to do in the BNL report is to normalize the calculations so that we are looking at the relative change. Once a siting model is established, we would still expect that these relative changes would then be superimposed on the new values.

MR. MARK: When you estimate latent fatalities from the CRAC Code, do they penetrate out to 50 miles or 500 miles or 1 rem or 1 millirem or what?

MR. ACHARYA: It goes out to 2000 miles.

MR. MARK: At that radius you are getting a millirem or something per person?

MR. ACHARYA: Yes.

MR. MARK: Then you multiply that by man rem times $10^{-14}$ for tose effects or something?

MR. ACHARYA: Yes.

MR. MARK: That is a number that one could develop, all right. It doesn't seem to have that much meaning.

MR. KERR: Mr. Okrent.

MR. OKRENT: Could I understand on page Roman XXII, where you give a table of results and you report

average latent fatalities per year --

MR. KERR: Excuse me. This document to which you refer is?

MR. OKRENT: The document to which I am referring is attached to a letter from Mr Papazoglou to Mr. Chelliah, dated October 15, 1982.

MR. CHELLIAH: That is our draft NUREG report, yes.

MR. OKRENT: This table, which gives average latent fatalities and then says "(per year)," is this per year of reactor operator or is it per year that these things occur?

MR. MARK: Year 49.

MR. ACHARYA: Maybe BNL staff should answer that. What the CRAC code out-propels, it is the latent cancer fatality per reactor year of operation over the lifetime of the exposed populace. In fact, in the CRAC model the plateau --

MR. KERR: Would you repeat that? It is the number of fatalities averaged over the life of the population divided by the number of --

MR. ACHARYA: A different practice is used by different analysts. In NRR we don't divide that. So I said earlier it should be up to the BNL staff to respond to this.

MR. KERR: Does the BNL staff have in mind what the original question was?

MR. PAPAZOGLOU: Papazoglou from BNL.

The third row of the statement represents the fatalities per year and per reactor year of operation. In other words, it is divided by 30.

MR. OKRENT: Well, I thought that that was a practice that people would stop using in discussing latent effects. In the first place, as the table has shown, it is completely unclear to the reader, and it could easily be interpreted as per reactor year just as is the executive summary in the report from WASH-1400, and I must say I am surprised that the practice continues.

I will just leave that as a comment, not a question.

Could I ask where in this report you discuss this question of flashing or not of the containment and where you discuss what you assumed about the effect of containment failure on core melt?

MR. CHELLIAH: I believe Section 6, the beginning of accident sequences. Maybe Dr. Trevor can specify exactly.

MR. PRATT: Dr. Okrent, your first question was where we talked about flashing?

MR. OKRENT: Yes, in the report.

MR. PRATT: That is described in the quantification of uncertainties in Chapter 7.3, and specifically it is under 73.4 where we talk about the early -- I'm sorry, no, no, no. That is the new scenario one. You are talking about the flashing calculation. That is discussed in 7.2, the audit calculations.

MR. OKRENT: And that is where I will find what assumption you made concerning the relationship between early containment failure and core melt?

MR. KERR: You could reword the question by saying where will I find the relationship between fatalities and early --

MR. OKRENT: Not fatalities. Containment failure and its subsequent effect on core melt. Mr. Ebersole had asked the question earlier to which an answer was given, and I just wanted to see whether the words here conformed with my recollection from a hurried scanning of this report on the airplane.

MR. KERR: Do you understand the question?

MR. PRATT: Are you talking about those classes in which we get overpressurization failure of the containment, failure first which leads to the core damage and failure of the pumps?

MR. OKRENT: Yes, sir.

MR. PRATT: That is discussed in Chapter 7.2, the audit calculations, and again, if you are looking at the table of contents, we do the MARCH, the CCRRAL and the CRAC analysis, and we follow the Class 1, 2, 3 and 4 subparagraphs there. So if you look at Class 2 and Class 4 descriptions, if you look at those descriptions, that whole section, the way we divided it up, in Chapter 7.2 we really looked at what they had done in the PRA and we tried to give, if you like, our calculations independently using our codes and our understanding of -- you know, eliminating things like flashing, which we thought it was a great upper conservatism. Then in Chapter 7.3 we went in and looked at certain areas where we thought perhaps they may not have been conservative and other areas where they may have been overly conservative and tried to establish an uncertainty bound.

MR. OKRENT: Well, perhaps if while we are talking about something else you can identify within one or two pages where you discuss this flashing statement and also where you discuss --

MR. PRATT: 7-44.

MR. OKRENT: Thank you. Is that the same place where I will find the effect of containment failure on core melt?

MR. PRATT: No. Again, if you want the bottom line calculations, that would be done -- you would find that in Section 7-23, which is the consequence analysis. But the development of the MARCH-CORRAL analysis, which gives you the release fractions, is really discussed in several places there.

MR. OKRENT: It seems to me it is not a MARCH-CORRAL kind of thing because I can conceive of situations where the containment failed and you kept the core from melting if you could get at it with water into the reactor vessel.

MR. PAPAZOGLOU: If I may, the assumption for the calculations conservatively was that given containment failure, core melt is inevitable. So there was no credit taken for the situation that you described.

MR. OKRENT: Is this discussed in your report or is it just something that is assumed?

MR. PAPAZOGLOU: That was an assumption that was made by Limerick and that is something that we accepted as given.

MR. OKRENT: Okay.

MR. PRATT: If I may further add also, we did recognize that as being a conservatism, and in Chapter 6 we do describe that point. We also mention that that was a conservatism, and when we looked at the upper and

lower bounds in Chapter 6, we looked at specifically that effect.

For instance, an interesting point from the work is they have the Classes 2 and 4 in which you see failure of the containment building leads to core melt, 50 percent of that probability, if you believe the trees, have got a very good percent. They have got a 50 percent chance that there will be sufficient containment leakage to prevent overpressurization failure. Nevertheless, they did assume that that 50 percent did fail and put it into that release category.

So again, that was a conservatism in the calculation. If you have enough leakage to prevent overpressurization failure, then you really don't have any mechanism to calculate the point.

MR. EBERSOLE: What was that last statement you made?

MR. KERR: You don't have any --

MR. PRATT: In order to progress to a core meltdown, one assumes a catastrophic failure from 144 psi at a very rapid reduction in pressure. It is assumed that that event, for a number of reasons, fails the pumps, which stops coolant into the vessel and leads to core melt. If you have a significant containment leakage, which they assume in that containment event

trees would prevent such a catastrophic failure of the containment building, it seems appropriate that it would assume that that would lead on to core damage.

MR. EBERSOLE: Let me see if I can straighten out that matter. Early on there were no standards for NPHS requirements, so the Safety Guide No. 1, before regulatory guides, were on NPHS. They confirmed at that time that the retention of the noncondensable fraction in the containment was essential to maintenance of NPHS, which implied that even if you had a small containment leak and lost the fraction of containment pressure due to atmosphere, you lost pump suction. So even a modest leak in the containment would ruin your pumping function. Is this reactor designed that way? It is just about at the vintage at which it just may be.

MR. PRATT: [Nods in the affirmative.]

MR. EBERSOLE: It means you don't have to have anything catastrophic: all you need is a stuck valve. You lose the atmospheric fraction and you have it.

MR. PRATT: So it may not be quite as conservative as we thought.

MR. OKRENT: On page 2-2, it says, for example, the low pressure core spray pumps can pump saturated water. The RSS BWR requirement may not always be met. So the implication here is that in fact it is

designed to meet that particular reg guide, which is number 1, and furthermore, it is not completely clearly to me just what all has been assumed in the analysis. It is because of this early statement that I was trying to find out why you gave the answer you did to Mr. Ebersole. It may be correct, but I didn't get to that conclusion from this early statement in your report.

MR. EBERSOLE: That last pair of lines up there about core damage contributors. Could you qualify something? Loss of high pressure coolant injection. In the first place, this vintage of design was turbine drive high pressure injection single train and was not especially reliable, so the faith was placed in automatic initiation of ADS, not human initiation of it. There was a 90 second time delay where human intervention was possible.

Does this mean that you are saying out there that operators will inappropriately insert themselves in an automated mode of operation and stop ADS?

MR. CHELLIAH: For this particular dominant sequences --

MR. EBERSOLE: The bottom two lines, under dominant core damage contributors.

MR. CHELLIAH: What is your question?

MR. EBERSOLE: The question is: There is only

a single train of high pressure coolant injection. It is turbine driven in that vintage plant. I thought they were all timed out to blow down after expiration of about a 90-second time element. They were not dependent on human function. Does this mean this design is different?

MR. CHELLIAH: Well, as you may have seen, all accident sequences here are induced by transients. For transients this is not automatic.

MR. KERR: Excuse me. I don't think you understood the question.

MR. EBERSOLE: Let me go through it again. Failure of high pressure core injection, if I recall it, was registered by the fact that one had double low level in the boiler. That automatically triggered ADS. There was a waiting interval of approximately 90 seconds during which the operator could insert himself and forbid ADS, but the ADS process was not dependent on human response. Is this plant different and one must manually initiate ADS if you get to double low level?

MR. CHELLIAH: For transients, yes, you need human action to initiate this timely. Maybe Dr. Papazoglou can explain how he selected the conditional failure probability value of .002, I guess.

MR. PAPAZOGLOU: If I may try to answer the

question, in the particular design that was analyzed for this revision of the PRA, the ADS does not start automatically for transient events. It does start automatically for LOCAS. But the second signal that is necessary for initiating ADS is not necessary in transient events. Therefore, the operator has to manually initiate the pressurization for transient events. He has to realize what is going on and take the appropriate steps.

MR. EBERSOLE: The critical one is containment pressure. So you are talking about transients which amount to throughline loss of coolant. That is a discrete step of transients. Any other loss is into the containment and you get the secondary signal anyway.

MR. OKRENT: It goes into the suppression pool.

MR. EBERSOLE: It goes into the drywell. Oh, no, you are right, it doesn't. Right.

MR. OKRENT: It will lose water but into the suppression pool.

MR. KERR: Any other questions?

MR. EBERSOLE: You are right.

MR. CHELLIAH: Also, just one comment I wanted to add, Dr. Ebersole. For Class 2 and 4 sequences, the containment failing prior to core melt, the temperature is rising up. BNL identified another effect so the HPSI

pump will fail.

MR. EBERSOLE: Can I, to better understand this -- I think this throws it into the following. A significant dominant core damage contributor is loss of coolant through the PORVs, which doesn't create containment pressure, therefore it loses inventory, and although you may get to a double or a triple low level, you don't get ADS, which you need.

MR. OKRENT: Is that correct?

MR. PRATT: Correct.

[Slide]

MR. CHELLIAH: Moving on. Now, given the limited PRA --

MR. KERR: Just a minute, please. You concluded that this was an important contributor on the basis of your evaluation? Your evaluation was different in Limerick, is that correct?

MR. PAPAZOGLOU: It is significant in both evaluations, both if one accepts Limerick quantification and our quantification. In both cases it is significant. Not absolutely at the same level, but it is significant.

MR. EBERSOLE: Before we leave this, this is an important point. There was quite a hassle about whether containment pressure was needed and required

input into the ADS function. Did you look at the aspect of not requiring that but just reading triple low level as the sole signal?

MR. KERR: Do you understand the question?

MR. PAPAZOGLOU: I think.

MR. EBERSOLE: In short, did you look at the reasonability of having the containment pressure as a necessary imput to ADS?

MR. PAPAZOGLOU: Yes. Right now we are in the process of doing exactly that. There is a problem with the ATWS situation. If one assumes that they make a design limitation that you will have in transients automatic initiation of the ADS system, then that creates some problem in the ATWS. We want to see what it would create.

MR. EBERSOLE: Thank you.

MR. KERR: Would you be willing to put that last slide back just briefly? I wanted to ask one more question. Your last transparency. The one that had the --

(Slide.)

MR. KERR: What is the difference between a dominant accident sequence and a dominant core damage contributor?

MR. CHELLIAH: Maybe going back --

MR. KERR: Is the first one a contributor to risk and the second one a contributor to core damage? You have one called accident sequence.

MR. CHELLIAH: These two are the dominant core damage contributors.

MR. KERR: What are the other two just above it?

MR. CHELLIAH: Are you referring to these two?

MR. KERR: Yes.

MR. CHELLIAH: These are just the most predominant accident sequence.

MR. KERR: What does it dominate?

MR. CHELLIAH: It is dominated by this particular high pressure coolant injection.

MR. KERR: I am not making my question clear.

MR. KAUFMANN: Frank Kaufmann, reliability risk. Ashok Thadani has sort of asked me to help broker these questions. The middle part of the slide that says dominant accident sequences is correct. Dominant core damage contributors really is referring to functions. Among the sequences, the most frequently occurring functions are those two functions.

MR. CHELLIAH: That's correct.

(Slide.)

MR. CHELLIAH: I indicated the same fact. If you look at the seven predominant sequences --

MR. KERR: That is enough. Thank you.

(Slide.)

MR. CHELLIAH: Moving on, given the Limerick Revision 4, you may be interested in what I am going to do. The Staff -- these are the three items we are going to move on. The Staff will review BNL's draft NUREG report. We will incorporate comments as appropriate, and we will issue a final NUREG CR report. Then beyond that we will focus our attention to some of the dominant accident sequences and determine and recommend any other additional actions are needed to reduce risk at high population density sites, such as Limerick. Yes?

MR. OKRENT: The Staff has some research efforts going on at Sandia to look at various reactor

designs, including, I think, the Mark II, to see what are the pros and cons and the cost-benefit tradeoffs for various features, whether they are preventive or mitigative. Is that somehow incorporated in what you have got there, or is that something not connected with this activity?

MR. CHELLIAH: Before we answer that question, are you referring to the IDCOR Sandia review?

MR. OKRENT: I don't think IDCOR is under the auspices of the staff.

MR. CHELLIAH: This doesn't come under Sandia review at all. This we plan to do --

MR. MEYER: Mr. Okrent, I will answer that question. My name is Jim Meyer, NRR Staff. As part of the staff evaluation, there is a program under way to consider the safety benefit of preventive and mitigation type features as related to the Limerick site. The Sandia work that you refer to has considered every type of containment but the Mark II, unfortunately, but we are proceeding with consideration of both certain mitigation features and through RAB certain prevention features which offer the potential for significant risk reduction.

This study is under way and will be part of the Staff evaluation that you have been told earlier

will be presented this summer.

MR. OKRENT: Okay. I guess at some future time we should have Mr. Minogue explain why the work at Sandia does not include a Mark II containment. I am sure there is some logic, although it escapes me at the moment. I will get back to the point I was raising somewhat earlier with Mr. Thadani, namely, that it may be difficult to go through a decision-making process when you have an incomplete assessment, an incomplete set of initiators. Are you doing things outside of this review of the PRA that you think will give you enough information on the other initiators that you can factor them in? Or are you going to make your decisions with this limited set of initiators?

MR. CHELLIAH: I am sort of --

MR. MEYER: Presently, we are working under the basic guidelines that we will be excluding external events. I certainly agree with your point that it will be an incomplete assessment if external events are excluded.

MR. OKRENT: What would it take to get you to do it? Does it take an ACRS letter to the Commission or additional remarks appended to a safety research report, or what?

(Pause.)

MR. MEYER: I am looking for somebody else to answer that question.

MR. KERR: I suggest you think on that question.

MR. OKRENT: Why don't you suggest to somebody that maybe the technical assistants to the Commissioners read the appropriate pages of the transcript?

MR. KERR: It still concerns me, though, that we are putting requirements on plants outside of existing regulations, if we are. It seems to me if the regulations are inadequate, we should change them so that one doesn't have to do a PRA or something and then back into this.

MR. OKRENT: You didn't hear me say requirements. I am suggesting that if they are going to make decisions, that they should be made in the light of an appropriate --

MR. KERR: I have not heard anybody here today say they are going to make a decision on the basis of a PRA. I have tried to get somebody to say that. What I heard is that this is going to be information available to the people who make decisions.

MR. OKRENT: I am sorry. I think we heard this morning that they made some decisions based on the PRA, namely, that they have talked to the licensee at

Indian Point about some modifications.

MR. KERR: That is right. They made a decision to talk to the licensee. That is a different kind of decision than the one I was talking about, which is to make a requirement. Maybe these are implicit nowadays. You don't have to make requirements nowadays. All you have to do is talk to licensees. But it seems to me that that is a somewhat informal way to run the licensing process.

MR. OKRENT: In this case. licensing may prefer the informal method.

MR. CHELLIAH: Could I comment, Dr. Okrent? The Limerick applicant has held off their PRA activities. They assumed a certain fix, and as I indicated, one is 3A. They have got other options which maybe I can mention to you. One is, they have some additional features to achieve alternative room cooling for the HPSI and RCSI rooms.

MR. KERR: I believe Professor Okrent is not too unhappy with the analysis of the internal behavior of the system, but he has some concern about external events, if I interpre his comment correctly.

MR. OKRENT: I don't want to sign off completely on the internal part.

MR. KERR: I said, not too unhappy. I didn't

say happy.

MR. OKRENT: By the way, one other question with regard to internal events. My impression from listening to some other presentations on other BWR's was that a leading if not the leading contributor to core melt frequency estimates was the unavailability of containment cooling. In other words, it was your class 2 category. In this particular study, using here either Limerick or the BNL results, this is not the case. Do we understand why there is a difference, assuming my memory is correct?

MR. CHELLIAH: I think you are correct, Dr. Okrent. If I recall WASH-1400 BWR, some of the other sequences are more dominant. Here it is not. Yes.

MR. KERR: Did you want to add something?

MR. PAPAZOGLOU: We are still trying to make a full assessment, but I can give you the present answer. The design of the containment heat removal systems includes a high degree of redundancy and also in the calculations the potential for recovering the containment heat removal systems that might be available at the initiation of an accident has been quantified and has been included in the calculations, and that results in a significant reduction of the failure probability of the failure of the containment function. It assumes 20

hours before the containment heat removal systems -- I'm sorry, containment heat removal function is actually necessary, and taking into consideration the high degree of redundancy and the potential for recovery, the failure probability is significantly lower than at other sites.

MR. KERR: Does that conclude your presentation?

MR. CHELLIAH: Yes.

MR. KERR: There are other questions?

(No response.)

MR. KERR: I am going to suggest a ten-minute break until we get on to the next part of this.

MR. CHELLIAH: Thank you, Dr. Kerr.

(Whereupon, a brief recess was taken.)

MR. KERR: According to information collected by Mr. Savio, there are two consultants, Mr. Davis and Mr. Power, who need to leave here by 4:00 o'clock. Is that correct?

MR. DAVIS: My plane is at 4:15 out of National.

MR. KERR: Yours is a little later?

MR. POWER: Yes.

MR. KERR: We will then probably call on Mr. Davis first and Mr. Power second. What I would like for

you to attempt to do in addition to other comments you may feel appropriate is to summarize the information that I find in both interesting and voluminous quantities in some of the reports.

I have read the reports and learned something, but at the end I found I had all this information and I had to make a decision, and what I wanted somebody to do was tell me what decision I should make. So if you can help me a bit in saying this report I reviewed after having said all this, it is either no damn good or it's a great report or whatever. Then that would be interesting. It would also be helpful if you could give us some advice, now that we have gotten this far, on what things need to be done next with some priority, not necessarily by the NRC Staff or the ACRS consultants, but what is it that now needs to be done next to get us closer to where we would like to be, and any additional comments you may want to make, especially in light of what you have heard today.

So, if you could at least keep those things in mind, I would appreciate it.

MR. MARK: You didn't suggest, Mr. Chairman, that they be totally uninhibited by the fact that there are some of the Staff still here. It seems to me they ought to be.

MR. KERR: I am always willing to accept comments from elder statesmen. Mr. Davis, are you willing to begin the process?

MR. DAVIS: Yes. Your questions require quite a bit of thinking, and I would prefer, I think, to send you a letter with a more in-depth assessment of those questions. What I would like to do is give you a couple of my reactions to what has been presented today, and to the extent that that may contribute to an answer to your questions, consider that part of the answer.

One of the things that concerns me a little bit about what we have heard is that -- is the use that is being put to the PRA's. As I understood it, and this is especially true for Indian Point, the PRA was done to try to establish some bound to the risk from the plant. That would then be used to make some sort of decisions about whether any action needed to be taken, but what I find is being done now with the study is an attempt to try to reduce the risk dominant sequences by some measures.

The problem I have with that is that in the Indian Point study there are a substantial number of what I might call pessimistic assumptions. Some people call them conservatisms. This, of course, applies to some sequences and not others, but what it does is, it

makes some sequences more upper bound estimates while others are best estimate.

The risk then is that if you take one of the upper bound sequences because it happens to be risk dominant, then you are really reducing something that should in fact be lower if it were done on a realistic basis. I could give you a couple of examples of pessimistic examples in the Indian Point study. One was the assumption that recovery of feedwater or condensate injection was not assumed as a viable option to auxiliary feedwater failure.

Another assumption they made was there was no equipment repair ability for six hours. This is according to the report. If now one uses the results of individual accident sequences to try to reduce the risk, he may very well pick up a sequence which has made a pessimistic assumption and it is not really a best estimate of the risk.

I think a corollary to that comment is that almost every review of a PRA seems to increase the probability of core melt. I think one of the main reasons that happens is that people look for things that they do not agree with in the pessimistic direction. Then, when the accident sequence is recalculated, only those factors are changed. Things which people agree

are conservative or pessimistic are not changed, and what you end up with is a review that is guaranteed to increase the estimated probability of core melt.

I must confess I do this myself, but I think it is a bad habit to get into. I think that we have to take these reviews with the proper perspective. I get the impression from the Sandia review that they concentrated on the probability of the initiating event, and did not do too much with the rest of the sequence, so that when they found an initiating event they felt should be higher, the probability of it, that is, they would repeat the sequence using the other numbers pretty much the same, and obviously, you will end up with a higher melt probability than the sequences in which the factors should be higher.

I might give you just a very brief rundown with some of the problems I had with the Indian Point study. One that has been around with us for a long time, and I still have not seen properly addressed, is taking account for degradation in the evacuation model for accidents which are initiated by external events. In other words, if an earthquake or a high wind causes the accident, it seems to me some adjustment needs to be made to the evacuation model. Basically, it would be less effective because of communications problems, the

possibility of disruptions of roads, and so forth.

The Indian Point model does not consider that. I think by the same token for external events perhaps the NRC should consider a new basis for risk criteria, because I think it is almost assured that external events that are of such magnitude to cause a plant accident is also going to cause quite a few consequences just by its very nature from other accidents outside the plant.

I had and continue to have a lot of problem with the evaluation of the V sequence probabilities. I won't go into that now, but they were in the letter I sent to you earlier. I am not sure what to do about that, but all PRA's I think have a built-in conservatism there in that they assume that if a double check valve failure occurs, you get a rupture of the low pressure piping with a probability of one. Most systems I am aware of have relief valves in that piping. They may or may not be sufficient to handle the abrupt overpressure problem.

Furthermore, that piping, even though it is designed for a lower pressure, has a substantial design pressure in it just because of the code requirements. Another thing that I found in the Indian Point study that bothered me a little bit was the failure

probability assigned to the auxiliary feed turbine pump. It is considerably lower than I have seen in other evaluations, and also lower than an assessment I did on a specific pump at another reactor.

I think those are the main comments I had, Mr. Chairman, on the Indian Point study. With respect to Limerick, of course, we heard about the problem already with the exclusion of external events. I guess the only thing I would add to that is, I did not see that qualification predominantly displayed in the study. In fact, as I recall, the study starts out by saying, this -- these aren't the exact words -- but it starts out by saying, this is our estimate of the risk from the Limerick plant. They are much lower than other risks, period. It is not until some time later in the study that the qualification is made that external events have not been included. I think there is a potential for misleading results from the way that is organized.

There were a couple of other problems I have. The LOCA loss of coolant accident pipe break size criteria does not correspond with the break size probability table that's in the report. I am not sure how that got sorted out when the event trees were eventually compiled. It doesn't turn out to be too important, since LOCA's were not a big contributor.

Another problem I had was on the automatic depressurization system. The report says that any break size smaller than .08 square feet requires ADS operation to get the pressure down such that low pressure injection can be effective. Any size larger than that does not require ADS. However, the ADS throat area is .11 square feet, quite a bit larger than that, and as I pointed out in my letter, there is an apparent discrepancy here.

In other words, the report assumed that if you had a stuck open relief valve, you also had to have ADS to get the pressure down, and yet the stuck open relief valve throat area is above the criteria for when ADS was required.

MR. KERR: Does that have to do with the fact that one possibly expects steam to be coming out of the relief valve and water to be coming out of the break?

MR. DAVIS: That is a possibility, although that distinction was not shown in the report.

My last comment, I think we have seen recently quite a bit of discussion about decontamination factors in suppression pools. The Limerick PRA tended to use rather pessimistic decontamination factors. I realize the returns are not all in on what decontamination factors one might be able to justify, but it can make a

tremendous difference in the off-site consequences. It seems to me like we now have at least the beginning of a substantial -- what will become a substantial body of information justifying much higher decontamination factors for suppression pools. This could change drastically the off-site consequences, at least the best estimate off-site consequences for BWR's like Limerick.

I think that needs to be kept in mind as we attempt to justify changes based on the current calculated risks.

That is all I had, Mr. Chairman.

MR. KERR: Thank you, Mr. Davis.

Mr. Okrent.

MR. OKRENT: I wonder if I could ask a couple of questions and maybe make an observation. I might note there have been times when a critique of a PRA led to lower results. I think I am correct that some of the studies initiated by the Staff which were then critiqued by the utilities involved went that way.

(Laughter.)

MR. OKRENT: But that leads to a question I will come to in a moment.

The comment about external events, I think, where you mentioned that there may well be serious off-site effects completely independent of whether there is a reactor accident is something that will apply some of the time for some of the people but not all of the time for all of the people.

It is not too hard for me to envisage an actual situation at an existing reactor where the earthquake, let's say, caused a damaging event which had little direct consequence on the population and region of interest.

MR. KERR: It's not hard for you to imagine that?

MR. OKRENT: I can envisage faults situated

with regard to reactors such that you might have a severe earthquake and still not have many buildings.

MR. KERR: You Californians have more imagination about earthquakes than I do.

MR. DAVIS: I think that's a good point, except that there is an incentive not to site a reactor on a fault. Of course, there are reg guides that prevent that. Whether they are effective or not is another question.

MR. OKRENT: I will stand with my statement. In fact, there are lots of reactors in the eastern U.S. that are quite consciously deliberately placed somewhat away from population centers. So again, it is a tricky bit. Let me just put it that way.

I guess if you could offer any comments at this time on what you think might be done next to, I will use the word --

MR. KERR: He is going to do that on the airplane going home.

MR. OKRENT: I will say evaluate. I don't know whether one can resolve differences that arise when one group critiques another or add more differences between the two groups and whatever. In fact, there is a related question. If you got them to achieve consensus, would it mean very much?

Do you have any comments now in that area?

MR. DAVIS: Nothing definitive. This goes back to the problem that we have had all along in how to handle peer review. I think this problem of resolving differences is a similar type of difficulty. I know you have had some ideas about setting up some supreme panel to try to at least have the last word on the PRAs. I guess I really don't have any definitive suggestions beyond something like that. But I will think about it.

MR. KERR: Other comments, questions?

(No response.)

MR. KERR: Mr. Power, are you next to lead?

MR. POWER: In my report to you I think I demonstrated that there are in these probabilistic risk assessments tremendous uncertainties in the accident phenomenology and the treatment of the source term, that whereas today we have heard about the uncertainties on the order of the factors of 2 between various reviewers of the accident initiation sorts of things in the PRA. In the area of phenomenology it is not hard to find factors of differences of even 50 to 100.

That poses a problem in using the PRA for risk evaluation, it seems to me, because how an accident progresses after it has been initiated and just exactly what are the radioactive releases associated with that

accident are what end up making the risk eventually.

So I guess in each presentation on the use of the PRAs both for Indian Point and the Limerick reactor have been on what the probability of the initiating events are rather than on the emphasis on what is the risk associated with the accidents.

This has been rather gratifying to me because I think that is where PRA makes its biggest contribution, identifying those things that can lead to an accident without looking in great detail on how that accident progresses, because I am not sure that in any trackable effort one could create an analysis of the progression of an accident which is initiated that you could ever get people to agree to within a factor of 10, given the current data base.

As far as a suggestion that the PRAs would then be used not as a basis for making decisions but as information for making those decisions, I guess I would have to agree with that because the PRA seems to have its strength in identifying what initiates in an accident, what equipment fails. I think it would be a mistake to say thou shalt reduce the initiators that are on the top of this list and not pay attenton to the ones on the bottom o the list, because that may recuire a judgment on the part of the people doing it. It may not

be wise to require Indian Point to build a structure that would withstand the historical earthquake. There may be other things that would be better and certainly easier for them to do.

That would be the bulk of my comments on what I have heard today.

MR. KERR: Thank you, sir.

Mr. Okrent.

MR. OKRENT: Let me explore your comments about the range of uncertainties. Let's take them one at a time, containment behavior and then source term, although they obviously interrelate.

You mentioned factors like 100. Do you think there are factors like 100 total difference in the estimate of containment failure likelihood given a coremelt sequence?

MR. POWER: I think factors of 100 certainly have been bandied around with respect to the rather strong containments like Zion and Indian Point. And those factors of 100 generally seem to come up in discussions where you are looking at the coupling between the progression of the accident and the performance of safety systems.

They have come up in a couple of contexts. One has been whether to give credit for performance of

containment coolers under various accident sequences and under the context of what happens as melt comes ex-vessel, does that in fact damage containment coolers via hydrogen burns of aerosol agglomeration or equipment failure burning up equipment?

So I think there are certainly factors of 100 given that you have initiated an accident and does that inevitably result and what probabilities have resulted in a gross containment failure. They are factors of 100.

MR. OKRENT: I guess my impression from what I have heard and read, let's say, in the last year or 15 months if I leave out now the reactor safety study and its approach, it was not clear to me that there were differences among the various people offering opinions or theories that large on the likelihood of certainly, let's say, if they were going to give what some people call a best estimate. I will call it an overpressure failure.

Let me take these one at a time. If that difference exists -- I guess it has not been quite clear to me; maybe it does -- and even then, in the question of whether it will melt through again in terms of these large dry containments or the specific ones looked at, I haven't perceived the difference that I would get if I

were to poll experts on the likelihood to be a factor of 100 total difference. Am I wrong?

MR. PEDERSEN: Pedersen, Argonne. There are and there aren't these differences. The differences come in predominantly, you can look at Indian Point and Zion. They come in those sequences that Indian Point and Zion have defined with epsilon probability. They have defined those epsilons to be on the order of $10^{-4}$.

Now, the containment split fraction for those two, in essence, winds up being $10^{-4}$, but if you --

MR. OKRENT: We can get into big factors by getting to very small numbers. But let me say that one percent is already small. So I don't get an additional factor of 100 by going to 1 in $10^{-4}$. The chance of failure is 1 in 100 compared to what WASH-1400 had said, it's already a small thing.

MR. PEDERSEN: That's part of the point I wanted to make. The containment split fraction for Zion and Indian Point was on the order of $10^{-4}$, and you would have to have a considerable reduction in the containment split fraction before those events would come back and be a dominant contributor to risk.

So just because we do disagree strongly on certain events by a factor of 100 does not necessarily mean that those are dominant events.

MR. OKRENT: Again, you said by a factor of 100. Does that mean you think the factor should be $10^{-4}$ instead of $10^{-2}$?

MR. PEDERSEN: Yes, it does. And I recognize that you would call that an insignificant event.

MR. OKRENT: Probably insignificant. When we talk about a factor of 100, that was one of the reasons I wanted to initiate this discussion. I think we have to be careful in what ballpark are we talking when we say a factor of 100, and the region that matters, is there a difference of a factor of 100 or is it a much lesser amount, even when you are talking about a limited set of sequences and not trying to mix it into a background?

In other words, I didn't read anyone as saying, given a coremelt, no matter what it is, 9 times out of 10 you are going to have overpressurization. That would have been a substantive difference, or, let's say, 5 times out of 10, 1 times out of 10 I would say is a factor of 10 difference roughly. Once you get below the 1 percent, it wasn't going to matter.

MR. PEDERSEN: I agree with that.

MR. POWER: I think I appreciate your question.

MR. OKRENT: I don't want to put positions in anybody's mouth. Usually, what I read were comments

which quite understandably were not quantified, but nevertheless -- so I am getting to your point. You said there are big uncertainties in the phenomenology. I think we heard of a factor of 20 assigned to the contribution to the hurricanes as an initiating event today. That is really a shift in the best estimate. That is not a difference between somebody's lower bound and somebody else's upper bound. And it turned out in fact to be a factor of something in a region where it counts; namly, you are already at a substantially large likelihood and this was a factor.

So I am not so sure that from what I have read that at least for this class, for the couple of containments, that the differences, when you look at containment phenomenology and their impact, are larger than the differences one gets from initiating events and their impact.

The source term part, I think, is harder to get a handle on because that will depend on combined effects.

MR. POWER: By and large, people are, I think, forced simply because they have no other good choice to adopt the reactor safety source term.

MR. KERR: Do you have a microphone near you?

MR. POWER: The problem when they hypothesize new phenomenology, as was done in both the Indian Point and the Zion PRAs, is by adopting that source term, that they are in some sense decoupling the release from the progression of the accident. There is not a clear-cut relationship between the two.

Failures of vessels at high pressures was not something the reactor source term can handle, but I am not sure they have a choice on what else to use because the current thinking is that in most cases that is a conservative selection and the releases are never going to be greater at the reactor safety source term studies for fission product release.

It does pose a problem for you if you are looking at risk-dominant sequences because you may be choosing the multiplier. If you multiply probability of an event times the amount of release associated with that event, if that multiplier there is wrong, then the

risk produced by that is going to be wrong by whatever fraction you have there. That is a problem I don't see any way around. I cannot fault somebody doing a PRA with a reactor safety source term. The reactor safety source term is, if nothing else, consistent. It's consistently conservative. If you start messing around with it, you lose whatever merit it has.

MR. KERR: Other questions? Do you have any more comments?

(No response.)

MR. KERR: In order of leaving time, I think Mr. Trifunac on my schedule is about 4:30. Would you be willing to comment?

MR. TRIFUNAC: I can comment only about Indian Point because that is the only report I really read. I won't go through the details on what I have written. I would comment in more general terms.

MR. KERR: Hold that microphone as close as you can without swallowing it.

(Laughter.)

MR. TRIFUNAC: The general comments are, I think we need some kind of accountability for these reports. I am getting a feeling where a massive report is written, it is loaded with assumptions which are really not accounted for. And I don't want to get into

details.

But the Indian Point report that I saw has a lot of statements in there that are just opinions of the people who wrote it. They are not supported opinions necessarily, and they are certainly not generally accepted procedures for that sort of work.

Rather than trying to do another probabilistic risk assessment study, it seems to me we would do well to go back to those we have done and try to see what credence we can put on the work that has been done.

This gets me to my next comment, which I think was not a high-level review. We have inadequate high-level review. We have review which essentially consists of reading what is there and trying to decide whether we do or do not like it. But the quality of the information and the quality of the conclusions that we get out of the functions of what good quality went into what is done there, I think we would benefit tremendously by increasing the quality of the review of these reports technically in detail.

You asked what I should like you to conclude from that report. I think the only thing I could venture a guess on is what you should not: It's that the seismic risk estimates are too low, that they are higher based on the assumptions in the report, but I

could not tell you how much.

I think the other question you had was what is next. It seems to me that it would be very beneficial to have several -- I don't mean two -- several, maybe three, maybe four, small but high-quality parallel efforts, efforts aiming at the same objective and answer in the end, but independent in their entirety.

I am getting more and more pessimistic about this massive, large-scale efforts which basically take the complex physical problem, chop it up into black boxes, subcontract each box, couple of boxes, to different groups, and then 2 years later putting all the boxes together and hope for the best.

I am not knowledgable on many aspects of reactor design, but when I look at the considerations in nuclear power plants, I think there is evidence in many examples where very complex and intricate feedbacks within one discipline and across total disciplines are eliminated by this procedure.

We have a group of seismologists and geologists making decisions that should be made by engineers, we have civil engineers making decisions that should be made by mechanical and electrical engineers simply because the procedural organization is such that the black boxes are separate and independent and there

is no feedback loop. The feedback loops should be procedural and should be physical and judgmental.

There are too many levels of intricate interrelationships in various decisions that have to be looked at altogether at the same time. The procedure and methodology of design should also be much more interdisciplinary than it is and so on.

I could go on for a long time like this, but I think those are general comments. I perhaps should stop right there.

MR. OKRENT: Well, you mentioned giving more credence to the reviews. I wonder if you could elaborate a bit on that respect.

MR. TRIFUNAC: Well, I have seen quite a few of these reports now. I haven't seen a single very detailed, very physical critique of what has gone into that particular report. Occasionally, we have heard in meetings such as this or similar meetings commentary on the adequacy/inadequacy of certain procedures in a certain way. But I have not seen any response to that.

I think there is too much inertia in simply forging ahead and doing some of these calculations and hoping for the best, that something meaningful comes out. If you have a particular group, you get a particular set of assumptions which are far from

generally accepted in the profession.

And I think that the quality of all these calculations and the decisions that come out of there would significantly improve if we had much more detailed, much more technical controversial, if you will, review of the procedures that should go into a PRA or related calculations.

MR. KERR: Without going into detail on the organization or the results, we heard today of a review done by Brookhaven and at least -- I don't know about the depth of the report, but the thickness is impressive. Is it this kind of thing that you have in mind or something more elaborate? I am not asking you now to comment on the competence of Brookhaven staff, which I am sure we all recognize is very high. But is the sort of thing you have in mind or something completely different?

MR. TRIFUNAC: Not at all, because I haven't seen that. I am having in mind a variety of reviews and reports I have seen. I have in mind the PRA that I have read in detail for Indian Point. What I am suggesting is that a very detailed, very voluminous work was done which in the end did present certain graphs, numbers, tables from which you were able to draw conclusions if you were to believe everything in between.

Rather than taking that report and the Brookhaven report and maybe another voluminous report and drawing a bar chart diagram and say, well, they come up to this number, that number, and trying to compromise perhaps between the two, I wish we could see much more detail, technical and more demanding review of what is done in these reports.

MR. OKRENT: May I try something on you to see whether it fits? Some time back we asked a few of the consultants who come in from the accident initiator kind of background, the probability of this occurring, to offer some suggestions on how one might go about improving quality of peer review for PRAs. And Dr. Mueller, who is sitting here, if I remember correctly, mentioned something that goes like this: There are going to be areas in the PRAs where there is controversy concerning the methodology and the phenomenology, and there may be such areas that one has the words of experts or whatever you want to call them who presumably do give this a very critical review and come up with, I suppose, judgments and bases thereof or recommendations or something.

I am putting some words into his mouth. But I believe my recollection is approximately correct. Is this something similar to what you are saying is a way

of giving credence, or is it something different?

MR. TRIFUNAC: Yes. This is one way. I believe that more detail, more serious review of certain procedures is in place and proper. We cannot avoid controversy and many variations of this. But I see too much inertia, large machine inertia-type of thing, just going ahead and doing it the way we have been doing it for some time. I think there is a lot of room for improvement at selected places.

Now, I cannot speak for all the accidents. I do not know about all the accidents. I can only speak about the area I am familiar with. There are certain obvious uncertainties that everybody agrees on. There are certain controversies on what should and should not be done. And I think more critical and more in-depth review and more in the way of accountability by those who do these reports in the broad scientific and professional community would help in eliminating arbitrary and unnecessary assumptions and perhaps reducing the uncertainties to those aspects which have to be considered that way.

MR. OKRENT: You used the term "accountability." I guess there is a kind of accountability that is considered, let's say, in what is called the academic world. A person submits too many

papers that, let's say, have proven to be wrong, or at least they are doubted for reasonably good reasons by much of the community. Unless he happens to be some historic figure in the past who is above everybody, he loses some credibility.

But do you think you have that kind of mechanism that can work here? It seems to me there is at least one complicating factor, in that the people who do these reports now have a client and he has certain interests, and I know that they can influence the output of the person doing the study. How would you get accountability in this somewhat different world?

MR. TRIFUNAC: That would be very difficult.

MR. EBERSOLE: May I ask a question? Dr. Trifunac, you mentioned about the need for interdisciplinary work and the complex ways we can get in trouble. Of course, if you are doing that, you must have occasionally thought how desirable it would be to have, if possible, a hopefully simplified and dedicated function to achieve the ultimate objective, which is to keep the core cooled. And we don't have that now. We are doing these PRAs based on complex systems that are in situ now. I would like to think that following your line of thinking we might hopefully look ahead to the time when we won't have to look at such complex

relationships and we can achieve a redesign for this complex purpose. You see the complexities in that?

MR. TRIFUNAC: I see the complexities, but I also see the problems that are sometimes not necessary. I don't think I can even think about looking at the coremelt. This is not my discipline.

But I see a lot of unnecessary problems that appear to me at least to be unnecessary with respect to earthquake-resistant designs, not introducing interdisciplinary reactions imposes the discipline of one on the discipline of the other, and these were problems it seems to me could have been avoided in the first place, maybe not altogether avoided, but it seems to me certainly they would be reduced.

MR. EBERSOLE: I see the designs as being an unnecessary waste with interedependencies which could be reduced.

MR. KERR: I don't think that is a question, is it?

MR. EBERSOLE: Well, I will put it as a question: Do you think that's the case in the seismic context? I might say now the designs are distributed and susceptible to failures all over the place. You can look in any direction and find a way to stop cooling functions. I think there are ways to consolidate the

critical functions.

MR. TRIFUNAC: I think that in the seismic area there are ways very much simplified to what we are doing now in a very large percentage of case. Now, I would hate to make a guess on what is a large percentage, but I think on many eastern sites there are simpler ways of going at the whole business.

On the other hand, I see a hesitancy on the part of the applicants and on the NRC to accept more detailed, more advanced, perhaps more recent methods of analyses which perhaps could mitigate some of the problems. Some difficult cases I see we find too much concern about complying with the rules and regulations because these are what the rules and regulations are and thereby getting into trouble.

So I do think that there should be a way, not a complicated one really, of simplifying all of the problems we get into for many cases, not all of them.

MR. KERR: Thank you, sir.

Any other questions, comments?

(No response.)

MR. KERR: Mr. Epler does not have to leave until 8:00 o'clock, I gather, so I am going to save the best for the last anyway and begin with Mr. Pedersen.

MR. PEDERSEN: Thank you. We have submitted a

review of both Indian Point and Zion -- or Indian Point and Limarick.

I will not go into any details of the review because that would involve too much time, but I did want to see that with respect to Indian Point and Zion, they are very similar reports, they were done by the same PRA organization. The methodology is nearly identical between the two reports.

MR. KERR: Which one was done first?

MR. PEDERSEN: You guys are a better reference to that, but I assume since the order in which we received them was Zion and Indian Point --

MR. KERR: Had they learned anything by the time they did Indian Point?

MR. PEDERSEN: I am not sure that they weren't done at the same time. In fact, the same MARCH calculations are used in both reports, so I actually think they were done at nearly the identical time. That is only an assumption.

MR. MUELLER: One of the consultants was Dave Aldridge and had cited some improvement from going to Indian Point to Zion, but I can't be more specific than that.

MR. PEDERSEN: One of the comments on Zion related to the source term multiplier. It is an effect of order of magnitude or two in reduction of risk, with very little justification. That is an important area.

There is certainly the potential payoff in the area of source term reduction, but as yet we are not in a position to absolutely know. One of the questions I think we have to address ourselves to in preparing a PRA is how do you handle these phenomenological areas where the phenomenology stage. How do you -- and there is consensus, at least among several people, that you will have considerable reduction in the source term. When you are preparing a PRA, how do you handle that? Do you handle that in the uncertainty, do you handle that in the mean value?

MR. OKRENT: Have you received a copy of the response from the Zion licensee to questions from the ACRS?

MR. PEDERSEN: I don't believe so.

MR. OKRENT: That may have fallen into a crack in the transition. Dr. Savio will make a note. You will not find an answer to the question you just mentioned. That is what reminded me.

[Laughter.]

MR. BENDER: Before you go on, let me explore that matter of the source term versus other kinds of information that are addressed in the PRA. We know with certainty that the statistics on reliability are not know very well, but yet we use them in the PRA and make

judgments about them, and we consider the spread. I wondered whether you didn't have some similar way of dealing with source terms.

MR. PEDERSEN: I am not an expert in the methodology.

MR. BENDER: It seems to me the same kind of question; you can deal with it essentially the same way. Do you think there is a range of values that might be used? You can take the extremes and look for a best estimate value. And I don't see a need to have a lot of experimental information before I do that.

MR. KERR: What I am saying is it has to be between zero and 100 percent.

MR. PEDERSEN: Yes, but you shouldn't make a bias. It appears as though Indian Point made a bias in uncertainties.

MR. BENDER: I am not trying to judge Indian Point. I am just looking for a principle.

MR. MUELLER: I guess I am missing your point because that is what we did with the Zion and Indian Point, giant containment event trees and they simply made a judgment; every time there was a need to go the safe way or unsafe way, they made a judgment.

MR. MARCHATERRE: You are saying there are large uncertainties. I think indeed that should be

done. Our comments simply related to the fact that how they made the judgment was not clear. It wa a document that was an important issue. We are saying we should look at the justification.

MR. KERR: If you were going to document something or if you were looking for documentation, what would you be looking for, a reference to another PRA that said we did it the way PRA number 3 did it? Because you see, enough of these are coming into existence that pretty soon there is going to be a lot of reference available. If that is what you mean by documentation, that doesn't give me a lot of confidence.

MR. PEDERSEN: No, I am not sure of what is out there in the field, but I believe that somebody could put together a reasonable case for there being a considerable reduction, if no other than the words from the reactor in Africa, the pseudoreactor. But I think it is possible to put together a reasonable case that would give you some satisfaction. It is the same case if you are going into try to convince you to do a lot of research in that area. You could at least go through a literature review and develop the best position you have.

One point that has come out in the review of Indian Point and Zion and Limerick is that there are two mechanisms of containment failure. The two mechanisms

are structural failure and excessive leakage. We have in the past concentrated on structural failure because that seems a little bit easier to come up with a number on structural failure, but we do have lots of penetrations in thes reactors that we have to worry about, just leakage of penetrations.

MR. KERR: Are you referring to the fact that penetrations may be leaky before the accident starts?

MR. PEDERSEN: That's right. Well, partly leakage before the accident starts, and then the pressure that you are inducing on them can cause some of the seals to open up and you can have excessive leakage.

MR. SEIDENSTICKER: The accident can also make it worse. It could induce further leakages.

MR. PEDERSEN: In the area of fire risk that we reviewed for Indian Point, really most of the concerns we had relative to fire risk we saw in the Sandia review. The only potential uncertainty along that line, the potential for convection heat transfers to cables of the gas layer building up, that was a concern that we had. The definition of the control room as a potential critical area.

The one area which we didn't see with respect to the fire treatment data, in trying to decide whether a fire is suppressed in a certain time after initiation

or whether it leads to cable failure, the authors of Indian Point referred to the data of Flemming, which is one of the references both in ours and in theirs. In reviewing that and another similar reference, which was Tserian -- is that the correct pronunciation?

MR. KERR: We will accept that.

MR. PEDERSEN: Both of them have reviewed the same data, and it appears as though they have two interpretations of the same data. The question in this is whether -- when you are trying to decide whether you can put out a fire, you have three times to consider. You have detection time, which is the time between initiation of the fire and when you found out the fire occurred. You have application time, which is basically the time between after you figure out there is a fire and the time you get down to the room. And you have suppression time, which is the time that after you get there, it is time to put the fire out.

The one reference implies that the data of Flemming is only the suppression time, where -- that is the reference by Tserian, and -- I'm not used to pronouncing these non-Swedish names.

MR. WARD: Pastolakas.

MR. PEDERSEN: In the Indian Point study they seem to refer to the data of Flemming as strictly

suppression times. Our interpretation is not clear. We would like to ask the authors to do a little more in that area. With respect to -- that is really about all I have to say about Indian Point.

With respect to Limerick, we again reviewed only the containment response. There is a very limited containment response here. The comments basically speak for themselves. The one comment we have is a summary comment with respect to the event tree that was chosen, the top level event tree. In several of the events there are several phenomenologies. There are several events that occur where you have to integrate the effects of each one of these to make a decision as to the probability that you assign in the end.

In one case there may be up to six phenomenologies, with things occurring at different times that you have to include. It appears to me as though if we were to improve the event tree a little bit to not have as many phenomena involved in each event, it would help us in the assessment of the review of the probabilities assigned.

I did want to make one other comment relative to external events. One is the title "external events." Fire has been lumped in the external events and really belongs back in the internal events.

Seismic, hurricane, tornado come close to my representation of external.

MR. KERR: My impression was that the classification of external event was based on an assumption that internal meant equipment malfunction, component malfunction, this sort of thing. In that sense, a fire is external to the system. It is not outside it, but it is not a normal part. But that may not be the way the classification occurred.

MR. BENDER: Excuse me. Do you have a feeling for the basis for deciding the frequency of fire initation?

MR. PEDERSEN: The source term?

MR. BENDER: The source term.

MR. PEDERSEN: It is based on this data of Flemming and -- they reviewed all the reactors' experience up to May 1978 and looked at the fires in each of the various rooms. The one I am familiar with is the cable spreading room, in which there were just two fires during that time.

MR. BENDER: Isn't that the kind of data you ought to have as a basis for estimating the likelihood of future fires, recognizing that these fire protection criteria have been promulgated, including the limiting causes of fire that were not in existence when the data

was generated?

MR. PEDERSEN: I would like Chuck to answer that question.

MR. MUELLER: Are you done?

MR. PEDERSEN: Yes.

MR. MUELLER: I will just slide in. I think one --

MR. KERR: Would you identify yourself for the lady?

MR. MUELLER: Chuck Mueller from Argonne.

One of the problems we have in all of these reviews and fire data is the mix between best estimate and conservatism. For Indian Point we had two fires in 300 reactor room years. It was that type of data base. The question is, if you don't use that, what do you use? "Pastalokus and some of us decided to use that as a base. How one can defend taking credit for criteria, I don't know.

MR. EBERSOLE: Could I ask a question just a minute? You are at the moment on the question of the probability of having a fire. Did you have any groundrules as to what is the susceptibility of the plant to fire? Would it have been modified to include Appendix R? There is a gross difference as to whether it was, on the one hand, as a minimum Reg Guide 1.75 or

had been altered to comply with Appendix R. Were you told?

MR. PEDERSEN: We weren't told, but I think I can partially answer that.

MR. KERR: We raised that question with respect to Indian Point, and it was evaluated.

MR. EBERSOLE: This is one inch separation.

MR. MUELLER: I didn't do the fire evaluaton.

MR. PEDERSEN: What they do is basically compare the propagation times to the fire.

MR. EBERSOLE: Reg Guide 1.75 permits the convergence of critical wiring down to a one-inch separation. Therefore, it can carry fires.

MR. PEDERSEN: I am not familiar with that level of detail.

MR. BENDER: Let me tell you why I am raising this. On the one hand, we are using data which does not account for the regulatory modifications, and on the other hand, we are defending the improvements in the fire resistance by taking credit for regulations in Appendix R, which essentially does the very thing which you didn't do when you used the data initially. There is something funny about that. Either you don't take a credit for Appendix R, or if you want to take credit for Appendix R, take credit for the reduction in initiators

as well. I guessI am not comfortable with what I know about what is going on right now, but it doesn't make much sense to me.

MR. MARCHATERRE: I would just like to make one point, that I wholeheartedly agree. As a matter of fact, this is a subject which myself and Carl Ott at Purdue pursue, taking credit for learning from past experiences and for changes in regulations. Carl, I might add, is quite an exponent of doing just that in these assessments, or attempting it, at least, on the basis that some attempt is better than none.

MR. BENDER: Well, I think any exercise in learning is bound to teach us something.

MR. KERR: In the process of considering other kinds of data, there is a table on page 3.7 of the Limerick review which gives what is called a summary of the frequency of transient initiators and the categories into which they have been consolidated. Among those that caught my eye was pressure regulator failure, which was said to occur .67 times per year, and loss of feedwater, which was said to occur .7 times per year.

Now, I do not understand why that sort of a failure has to occur so frequently. Is that really a valid set of data? Are these systems so poorly designed that that frequently one has a failure of the pressure

regulator and that frequently one loses feedwater? I mean when you see numbers like that, do you go back and make sure that somebody has not made a typo?

MR. EBERSOLE: I don't find anything horrible, Bill. That sounds like commercial grade equipment.

MR. KERR: Well, this shouldn't be commercial grade equipment if it fails that frequently, Jesse.

MR. EBERSOLE: But it is traditional to have it.

MR. KERR: Well, I guess I don't see why one does PRAs when one has such lousy equipment. It seems to me the obvious thing is to fix up something like that. I'm a front man for Epler.

MR. EBERSOLE: You are setting the stage.

MR. KERR: Those are valid numbers as far as you know?

MR. MUELLER: I don't know. I don't have any familiarity with that.

MR. KERR: Well, someone who is in the review process is on the lookout for these and says, aha, this number must be a typo or something? They don't just take these numbers and say -- I hope. Marchaterre, you worry about this sort of thing.

MR. MARCHATERRE: I think we do, but you also have to remember that at least in our case, the review

was looked at in certain critical items and was not attempted to be looked at in its totality.

MR. KERR: You were answering Mr. Bender's question, I guess, when I interrupted you.

MR. MUELLER: One thought that struck my mind. Pete Davis had mentioned the fact that a review is almost bound to guarantee an increase in risk. It would seem to me that if each reviewer, especially in a full-scale review, were chartered, if you will, to make a real best estimate assumption where one goes through and actually comes up with his best value, that may be one way of introducing what Dr. Trifunac, I think, would refer to as accountability. It is obvious, as Pete mentions, it is very easy to go through and accept all the conservatisms because, again, these are blends of best estimates and conservatisms, it is easier, if you will, to attack those things that you know about that are perhaps not quite so conservative. So that is at least one suggestion.

Conclusions, where do we go next? I guess I would like to see a reassessment of the key sequences for Indian Point and Limerick using true best estimate guesses on all the different branch points to get out to both the core melt and the peak fatalities. One thing Dr. Okrent mentioned concerning source terms, how important are these uncertainties, well, they are part and parcel of getting from core melt frequency to acute fatalities.

Looking at some of the results, Limerick has a core melt frequency of 1.5 minus 5. One out of every six core melts kills 100 people. My gut feeling is that that is not true. Okay?

For Zion, the published values were 4.2 minus 5 for core melt frequency and 4 minus 9 for a factor of 10,000 in the same transition. Obviously, that is -- Dean mentioned it before. It included both containment assumptions and the assumptions on how one lumps all the conservatisms put into the analysis before that.

Certainly source term uncertainties are a key part of that, so I think it is a very critical issue.

The last thing on documentation of accident scenario assumptions, I don't know, other than simply listing the applicable experiments, applicable analytic tools, what one can do beyond that. I guess I would

like to see a little bit more of the latest Henry scenario or whatever, because it seems that everybody is looking at things and thinking about all the terrible things that can happen. At least there is one guy who is looking at it from the optimistic view, saying, if this scenario takes place, we can get reductions rather than worst case episodes or scenarios.

That concludes my remarks.

MR. KERR: Mr. Marchaterre, did you have anything to add?

MR. MARCHATERRE: I would like to make just one comment, following up on some of the previous discussion. From the complex phenomenology and perhaps the need for peer review, I think that in my own opinion there are enough people that have thought about degraded core phenomenology now that one could begin to -- I am not optimistic enough to say we will reach a consensus opinion. You may well have a minority-majority report. But I think one could get a reasonably respectable group of people together who would benefit from interchange and questions that people have about, for instance, some of the phenomenology that was in the Zion and Indian Point study.

We raised some issues. We tended to raise them as questions. I think there are -- I guess my

opinion would be that there are answers to these, that in many cases at least some of the differences could be ironed out. As I said, I am not optimistic enough to think we would reach a consensus opinion on probabilities of things, but we might narrow -- it might be possible to narrow the range. I think that is probably a worthwhile exercise to undertake.

MR. OKRENT: Can I pursue that? Suppose one were to try the exercise you just suggested. About how many people overall would you envisage being involved, and about how many five-day weeks would you envisage each had to devote to this to accomplish the review and the writing of the report and so forth?

MR. MARCHATERRE: I guess I would say -- I am just mentally going through names in my mind of who might be involved that would give you a spectrum of opinion. I would say it would be probably in the range of six to ten people. In terms of time, I think it would probably be a substantial effort.

MR. OKRENT: I can't quantify substantial.

MR. MARCHATERRE: I would say you would probably wind up with each of the persons having, in total, I would say, would wind up spending a couple of man months between the meetings, negotiating back and forth, probably spread out over a long period of time.

MR. BENDER: I am not sure just what kind of subject matter that group might address.

MR. MARCHATERRE: I was addressing my perhaps seismic. I was just addressing my effort to the one area I am most familiar with, which would be degraded core phenomenology.

MR. BENDER: I understood that is what you were talking about.

MR. MARCHATERRE: I would say an example would be, for instance, pick one of the tough ones. What would the consensus opinion be on probabilities of steam explosions for some of the various scenarios, some of the various accident sequences? The questions that have been raised, for instance, on crest stability. What are your estimates that that is -- I am raising these as questions. I have no opinions.

I generally would say that the material we have seen, I would say I generally agree with. We have some differences of opinion, but that's the kind of thing I am talking about.

MR. KERR: Dr. Trifunac?

MR. TRIFUNAC: This is a comment. We do a PRA. We get a list. This could happen, this could happen, this could happen, and so forth. And we add some numbers to those. We look at how this was arrived

at. Basically, we have a one-way full tree sequence which has branches, usually two or more branches at each level.

Now, I think what would be very useful for those people who want to use the results in their decision process to examine at what locations of the branching we are not justified in assigning the 100 percent probability of having covered all of the branches, because I think the past experience with accidents suggests that we can predict, what, 70 percent, some such percentage of accidents, maybe 20 or 30 percent that come from those branches with surprises we didn't expect, and I would expect that at certain places we do the branching, we should be able to say that there is another scenario that is conceivable that we have not considered because we have an educated judgment that it has perhaps a 2 percent chance of taking place.

So that in the end, when we get the total answer that we have a proviso saying that we believe in a judgmental way that we have covered maybe 80, 90, 60 percent of the cases that we should have covered, and that is something that would be helpful for those people who are not in the probability business, but who want to use these numbers as a contribution to their thoughts.

Also, in all the fault trees I have seen, the branching is forward, multiple branching. I just have difficulty seeing that there are no feedback loops that go from one side of the tree to another because some things may have happened simultaneously, but that is a more complex subject.

MR. KERR: Did you have anything further?

MR. MARCHATERRE: No, I am finished.

MR. SEIDENSTICKER: They have covered my major comments with regard to containments. I don't know if you mentioned anything about the reactor vessel. I guess in all three of the things we looked at, Argonne, Zion, Indian Point, and Limerick, not very much was given in the way of discussion, let alone documentation of the reactor vessel. I saw interesting sentences about control rod tubes melt. It blows out, and that's it. I'm not very convinced about that, and I can't convince anybody else when I do a job on that, and I think that ought to be certainly done with a lot more detail to convince -- if it's important, and I understand it has a reasonable amount of influence as to the amount of core melt that would come out and how fast it would come out; that certainly ought to be looked at.

I find that that is --

MR. KERR: When you say looked at, do you mean, have you given it enough thought so that it would take experimental work, or is it analytical work?

MR. SEIDENSTICKER: I think it is primarily analytical work. It might very well be one of the things that John has mentioned. I don't think it is the kind of thing that you have to embark on a four-year program. I think if you get three or four or five or six people together that know about these things, including the reactor manufacturer, I wasn't too clear that was the one that was involved. I would go back to him first. I don't know if he was the one that made those estimates, but he may give you a different idea of where it failed, but I think if you could get closer to a consensus on that, I don't think you need any experimental work.

Just a comment on the difference between Limerick as compared to Zion and Indian Point, Zion and Indian Point being a package, the depth of the structural work on Limerick was far less for, I think, a more complex structure. The types of failures and the types of diaphragms and connections and things that could happen in that kind of containment I think deserved a little bit more attention. If they spent as much time as they had on Zion and Indian Point, there

might have been more things we could have commented on. It just simply didn't have it.

We made a few comments, I believe, on melt through or partial melt through of some of these horizontal diaphragms and what effect that might have on the containment capacity. I think the thing, if I understand what you had asked earlier of what might be some bottom line things to glean, Number One, of course, the reactor vessel failure mode is somewhat up in the air. The other one has to do with -- this is self-serving to some extent, because we just recently made a submittal along with others to the NRC for research in the containment leakage characteristics for -- at the request of the NRC, and it is to be inputted into the whole program for containment safety margins.

That is, to get a much better balance between both structural failure and the leakage rate failure in containments. I attended, as I think many -- I know Chet Siess was there, and I know others were -- in June at the workshop of Sandia in Washington, that there was not a crisp definition of containment. The answer was pretty clear. It sort of touches on what Dr. Trifunac said. Virtually everyone there was a structural engineer except Bob Henry, and he talked about steam explosions. Everybody else was there to explain how

their structure was behaving, whereas in fact I think you have to attack it as a structure and leakage rate failure.

You need a systems approach, if that is the right way to use the word "systems." I do not mean pushing that by saying we should downgrade the structural work that the NRC has in place. We still don't know much about the way in which containments will fail. There is an awful lot of disagreement. It is very sensitive as to location and perhaps even the mode of failure.

MR. BENDER: It is not uncommon practice to design structures so they are predicted to fail in a certain mode.

MR. SEIDENSTICKER: Right.

MR. BENDER: And if you want to build containments that way, you certainly could. Do you have in mind trying to look at that aspect of the question?

MR. SEIDENSTICKER: Yes. In fact, I think at some of the information meetings a year or two ago in Washington that Jim Meyers was at, we made the comment that people were concerned why Zion, for example, didn't show weakness at the penetrations, and as you and I served -- I don't want to say how long ago it was -- on some of the concrete code committees, they were

deliberately designed so that they would not fail there, so that you would get ductile failure elsewhere.

Then, when I went back home and started looking at some of the FSAR's that we had on hand, I found that some people put penetrations where Zion wouldn't have. In other words, what was good for one reactor you couldn't generalize. It wouldn't have been a good argument for the next prestressed concrete or reinforced concrete.

So, I agree with you, Mike. I think that is one of the advantages that, for example, concrete had, to put the failure mode where you wanted it, but apparently it got lost in the shuffle.

MR. BENDER: Well, we have sort of got a one-horse shay out there right now. There is a question as to whether that is the right way to engineer these structures.

MR. SEIDENSTICKER: And of course the question on containment is, it is all based on strength, and now we are trying to analyze it not only using more sophisticated PRA type analyses, but going way out in the plastic range, where we are talking about deformations of inches and not fractions of an inch, where everybody gets excited when they see a small crack around an opening.

So, I really think that growth structure behavior should be continued. I just want to make the pitch that I think the NRC's recent request for work from four or five organizations on penetrations definitely needs the ACRS's support, and I am sure from what I have heard from Dr. Siess this has been pushed very hard in the past before the ACRS, and I am glad to see it coming along.

The future thing, I just wanted to make a couple of comments. One is, I agree very strongly with Dr. Trifunac on this idea of trying to split things into pieces for the review. I think one of the advantages we may have had at Argonne was that there were four or five or six of us, that we may have worked independently, but we had the opportunity to get together at times, and we brought different disciplines to bear.

It would have been pretty helpful to have heard the writer of the PRA give a two to five-hour presentation as to what he is trying to do. That would have been very helpful, and maybe that is very hard to do. I suspect it is not easy to make a short presentation of a 13-volume document.

On the other hand, it is pretty hard to find it. I don't know what question Dave was asking earlier, but you were looking at 7.2 or 7.3? I have a lot of those. A road map would have helped. And I think they are definitely needed. But that is just because these things are new, and I would not want to push for uniformity.

I think the last thing is this idea of separation. Again, I want to re-emphasize that I think the review process can be greatly emphasized not only by attacking specific problems, but by bringing together different people, just as you would for a site selection. You really ought to send out a seismologist, geologist, structural engineer, and probably lawyer, and someone else.

MR. BENDER: You lost brownie points right there.

(General laughter.)

MR. SEIDENSTICKER: Well, at least a politician at any rate. That is the sum and substance of my comments.

MR. EBERSOLE: Can I ask a question? You touched on something that sounded mightly like it related to control rod drive ejection, the thimble failure. Is that what you were talking about?

MR. SEIDENSTICKER: As I understand it, when we read the reviews of how the reactor vessel, the bottom head was to fail, that is, how the core melt was to get out, it was on the basis of a nozzle for the control rods. There was a partial penetration weld. I don't know if this is true for all the reactors, but one that I know for sure --

MR. EBERSOLE: The reactor is shut down at this time.

MR. SEIDENSTICKER: What is happening is that the molten material is getting at that weld. It is weakening it, and it ejects it in the sense that it comes out. We question that on the basis that that may not be credible, because by that time you may jam the nozzle.

MR. EBERSOLE: You are not worried about a reactivity accident, are you?

MR. SEIDEENSTICKER: No, just the structural failure.

MR. KERR: Anything else?

(No response.)

MR. KERR: Mr. Epler, we come to you.

MR. EPLER: I guess everybody knows that I don't know anything about PRA. I am not an analyst, and the things I have to say, if they are shocking to

anybody, please believe me, I don't intend to be offensive. But I observed that having a PRA and having identified some major contributors, there is an enormous pressure to fix those specific items and no corresponding pressure to fix those that have not been made apparent.

I could illustrate what I mean by this example. We have events that occur frequently, like loss of load turbine trip and reactor shutdown. We have some that are very rare events, but you see a great deal of attention because they are spectacular. These would include large break LOCA, an airplane crash into containment, pipe whip, turbine missiles, and a lot of other highly improbable events that receive rather extensive attention. Let's call that Group 1.

Group 2 would be those events having similar probabilities, but we haven't thought of them yet. I don't know how many of those there are. I know a few. Group 3 would be those that we can't do anything about, like sabotage or acts of war. So, if you look at the ratio of those events that we spend a lot of effort on compared to those that we cannot fix, then we wonder if that isn't just about a factor of two.

I don't want to suggest that it is a factor of two. I am saying we simply don't know.

Now, what I am paying attention to is those events that we have not thought of, or having thought of them, we cannot do much about them. Let me first remind you that Bill Stratton, about 1960, wrote a paper in which he described between two and three dozen events where critical assemblies shut themselves down by the mechanism of violent disassembly.

If you look at it, the designs were completely inept. They were thrown together by people who had done them extremely informally, and today we are very careful in our designs. We have learned a great deal, but we still have some errors, some we even recognize as not very good, but we can't do much about them because they are engraved in stone. They have been approved, they have been licensed, and we still do them that way.

I could give some examples, but I want to get through. We would expect to reduce the frequency of design errors, although it has been a large contributor to the spectacular events. Component failure has received a lot of attention. It is not much of a problem. It is easily fixed. Redundancy does it very well, but redundancy brings in no problems.

If you have two and one breaks, you fix the other one. Now they are both broken. This has happened many times. We have lost turbines, turbine bearings,

and other rather spectacular equipment failure just by the mechanism of servicing the wrong unit. We have another mechanism of testing which is essential. When you have redundancy, you have to test to find that the first one has not failed. Testing has been a very large contributor to rather serious systemic failures. I could give a dozen examples.

MR. OKRENT: Up until now it sounds like we should have one system that we should not test.

MR. EPLER: No, we have to be able to accept the consequences of this mechanism, because we are going to have it.

MR. OKRENT: I am only kidding.

MR. EPLER: I know it. Now, having redundancy, now we have a new mechanism. Having multiple unit sites, we now service the wrong unit. And we have had some rather spectacular consequences there, like losing the turbine bearings and other things. Then we have, strangely enough, another mechanism for failure. That is directions from the front office that are inappropriate.

I could give several examples of where people have been constrained to do things by directives from the front office that were just plain wrong, and resulted in some rather disagreeable consequences. Then

there is one that is really shocking, directions from the bureaucracy in Washington, and this could be either from the NRC or the DOE, and I have examples of both that are entirely inappropriate.

Now, these don't appear in published accounts. They have been troublesome in the past. I don't think we are going to fix any of those. So what do we do? Well, I think to me it is obvious that there is only one thing that can be done, and it must be done. We have got to increase the on-site capability, because those guys are in the best position to fix all of these. We can't sit here in Washington and do it.

I am not sure they can, but only they can.

MR. KERR: What is the probability?

MR. EPLER: Ask these people.

MR. KERR: Are there questions? Comment?

(No response.)

MR. KERR: Do you have anything to add to the proceedings? Mr. Okrent? Mr. Ward? Mr. Bender? Mr. Ebersole?

(No response.)

MR. KERR: What is your view of the utility of the type of PRA's that you are seeing now in the decision-making process? How comfortable do you feel with using them?

MR. PEDERSEN: We brought along John to answer that.

(General laughter.)

MR. MARCHATERRE: By that, do you mean I have reached the age that I am expected to be the only philosopher?

(General laughter.)

MR. MARCHATERRE: I haven't really thought about that question a great deal, but from the standpoint of my normal answer, top of the head answer, it is that it is very useful if I was in a position of having to make decisions on plants or changes in plants. For all their imperfections, I think I would find a PRA on the plant very, very useful.

MR. KERR: Which part of it, the quantitative or the qualitative part?

MR. MARCHATERRE: I am not terribly interested whether the numbers are $10^{-4}$ or $10^{-6}$, but it is really qualitative. What are the dominant contributors to risk?

MR. KERR: We are sort of now talking about a failure modes and effects analysis, aren't we?

MR. MARCHATERRE: Not really. I am adding one more comment to it. At least while I am not interested in the absolute value of the numbers, I am interested in

the comparative, in comparative numbers, in the sense of what are the dominant contributors to risk, and what might be done to reduce this.

MR. KERR: But why aren't you interested in the absolute numbers? As Paul Davis pointed out, I think it is an extremely important point. You go through these things. Let's say you are very conservative in one sequence, so you compare other sequences and have ten plants using the same conservatisms, and you have a relative number. Now you have to make a decision, do I spend resources to fix that sequence, and really, the conservatism is such that I should be putting the resources on some other sequence, which has been a best estimate analysis, which on paper looks like it is much less contributing to risk, but actually it might be more.

MR. MARCHATERRE: I think that is a good point.

MR. KERR: If you are assuming absolute numbers, you have to worry about it, perhaps a good bit.

MR. MARCHATERRE: I guess implicit in my comment was, the sequences were all done with the same degree of conservatism or lack of it.

MR. KERR: Well, we know they are not.

MR. MARCHATERRE: I think that has to be an input into the thinking as to what we are looking at in the PRA and what degree of conservatism has been applied to the various sequences. I think your point is well taken.

MR. KERR: There is one other question which has to do, I think, with how one uses it and what one does. What have you seen so far if you had to assess the conservative and individual PRA of a specific plant and compare that with the differences that one might find between a generic and a specific analysis? Which would you say is likely to be greater? What I am really getting at is, shouldn't one do a good generic analysis and assume that at least in a general sense one can use that for making decisions, and does one have to get to the specific plant in order to accomplish something?

It seems to me the answer to my question does not settle that, but I think it has something to do with an answer to that question.

MR. MARCHATERRE: I would like to see what the other people think, but just in view of looking at these three that we have reviewed, it seems to me that you really have to be specific to the specific plant. Let me qualify that by saying there are big chunks that could be generic in nature. The phenomena are basically

the same. I think the example there was, the things that were done for Zion were particular to Indian Point.

If you had those kinds of things agreed to and ironed out, than you could concentrate on the specific things, but I think that the answer is, you have to look at the specific plant, when we use it in a decision-making mode. That is my view.

MR. KERR: Suppose what you are trying to decide is whether the risk posed by plant in some location is too great or greater than some other plant, and you are not at this point yet trying to fix up, you are just trying to decide what is the risk. It seems to me that unless you can convince yourself that the difference among the plants is greater than the uncertainty in the individual analysis, you do not gain anything by doing a specific analysis. If you go to the next step and say I am going to try to reduce risk, then you may have to lock at the individual plant in order to know where to allocate your resources, but many of the studies that have been asked for presumably have been asked for not to fix up, although apparently now they are being used that way, but rather to decide, is the risk comparable to or too great or something of that sort.

And there it seems you are asking an overall question and not asking how the individual system or subsystem has performed, and for that there is a real question in my mind as to whether you buy anything by going to the individual plants.

MR. MARCHATERRE: I think that is a valid point. I would just make one comment which is, I think, that at least my view in looking at Zion, for instance, because in fact at the time Zion was licensed there were questions about the site being a populace area, and in fact it has a strong containment. That kind of plant specifics has to be added, I think, to what you are suggesting.

MR. KERR: I don't hold the answer to the question I am raising, and I don't pretend to, but it seems to me it has an influence on how one allocates resources.

MR. BENDER: If I were to accept the premise as you stated it, it would not be a lot different from saying, when WASH-1400 picked four representative plants and made their judgments on the basis of that, you would be able to take that judgment and apply it to all of the plants that have been engineered.

MR. KERR: If the answer is the uncertainty in an individual is bigger than the difference between

members of a class, it seems to me one could draw that conclusion.

MR. BENDER: That is an important premise that maybe didn't come out too well. Maybe we don't know.

MR. KERR: I certainly don't know, and that's the reason I'm asking the people who have looked at these things.

MR. BENDER: If the 30 percent uncertainty dominates the risk, then trying to fix the 50 percent will not mean very much, but if that is the case, then dealing with the plant specifically won't help either.

MR. OKRENT: I think there is a considerable difference between a plant that has an estimated mean value of core melt, let's say of $10^{-4}$ with 5 percent and 95 percent numbers of $10^{-3}$, $10^{-5}$, and another plant that has an estimated mean value of $9.5 \times 10^{-4}$, even though it falls inside the uncertainty band for the first one. So, I have to be a little bit careful about saying, well, something falls within the uncertainty band, and therefore is not really different, and so forth.

In other words, it seems to me the question is fairly complicated.

MR. KERR: I don't pretend to know the answer.

MR. OKRENT: The question isn't, but the answer is.

MR. KERR: I agree. I have been asked it, as a matter of fact, but we are now putting a lot of emphasis on individual analyses, and what I have seen come out of these in many cases are factors of two or three difference. Once in a while, a factor of ten. And I am not sure a factor of ten is significant, but I am pretty well convinced that a factor of two or three is not at all.

MR. BENDER: A lot depends on how many orders of magnitude you are working with. If you are down in the $10^{-6}$ range --

MR. KERR: Perhaps that is exactly where the uncertainties lie. They don't like up in the higher figures.

MR. OKRENT: No, but we have seen them in the $10^{-3}$, $10^{-4}$ region as a factor of ten difference or more between the two estimates just today, so that is a big, big difference in a pretty big number.

MR. SEIDENSTICKER: Could I make one comment? Certainly from the structural point of view of the overall containment system, I think that it has begun a movement at least for those who have made a significant effort on the PRA's to look at the failure modes of

their containment system as a system. I think that has not been true up until now. It has been codified and it is the usual engineering demand to give me, what do you want, one-tenth of 1 percent leakage rate per day, design pressure, and that sort of thing.

And what we find, for example, in doing the survey for the NRC on penetrations, and maybe that partly answers your question on generic versus specific, the variations in both types of containments in the material used, the sizes, the locations, the types of penetrations, some equipment air locks or hatches are on the inside, some on the outside, by the time you get all done, the variabilities between plant designs are very great and very hard to pin down, and each turns out to have strong points and weaknesses that are different, that on the surface look very different.

So, I don't know if that sheds any light at all on your question.

MR. KERR: What you say is very true. On the other hand, I gather from what the staff has concluded that if you pick an individual contention, that the staff does not believe that they now know how to predict the performance of that containment under serious accident conditions, which leads me to believe that there's a great deal of uncertainty in making

predictions.

MR. SEIDENSTICKER: I am always in favor of a backup approach. The bottom line of our propcsal, not a proposal, but a proposed plan for containment penetration is, there is no hope. There is not enough resource money and time and people to test every possible containment penetration. You will have to do what amounts to a generic study both experimentally and analytically.

MR. KERR: It is not a good analogy, but in a way it seems to me that what we are sort of doing is taking mortality statistics, which insurance companies can use rather well, to predict populations and trying to use them to predict how long I am going to live. I don't think that is necessarily likely to be very successful. That is an oversimplification, but does anybody have any further questions or comments?

(No response.)

MR. KERR: This was scheduled to end at 3:00 p.m., and it is ending at 3:00 p.m. plus a few hours. So, I declare the meeting to be adjourned, with thanks to all of you who participated.

(Whereupon, at 4:55 p.m., the meeting was adjourned.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

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in the matter of: ACRS/Subcommittee on Reliability and Probabilistic Assessment

Date of Proceeding: November 3, 1982

Docket Number: _____

Place of Proceeding: Washington, D. C.

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

Jane N. Beach

Official Reporter (Typed)

Jane N. Beach

Official Reporter (Signature)

# SUMMARY OF BNL'S

# MAJOR REVIEW RESULTS OF

# LIMERICK PRA

BY

E. S. CHELLIAH
RRAB/DST/NRR

## REVIEW RESULTS OF CORE DAMAGE FREQUENCY

- LIMERICK PRA, REV. 4 - $1.5 \times 10^{-5}$/RY

  BNL'S REVIEW - $1.1 \times 10^{-4}$/RY

- HIGHER ESTIMATE DUE TO:

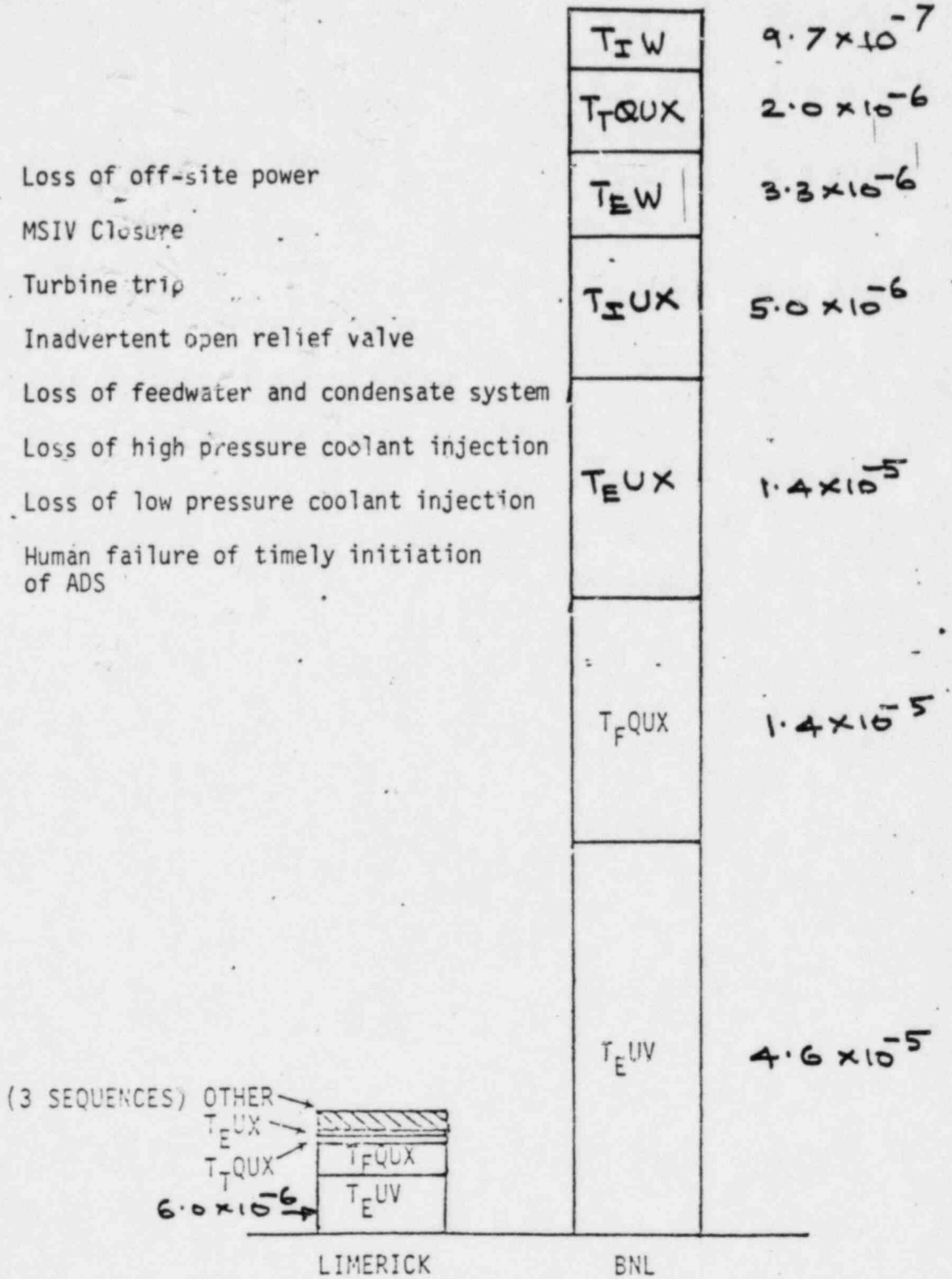
  (A) BNL ADDED SOME SUPPORT SYSTEM DEPENDENCIES

  (B) BNL MODIFIED PRA EVENT TREES AND FAULT TREES

  (C) BNL REVISED FREQUENCY VALUES OF INITIATING EVENTS

## DOMINANT ACCIDENT SEQUENCES BY CORE DAMAGE FREQUENCY

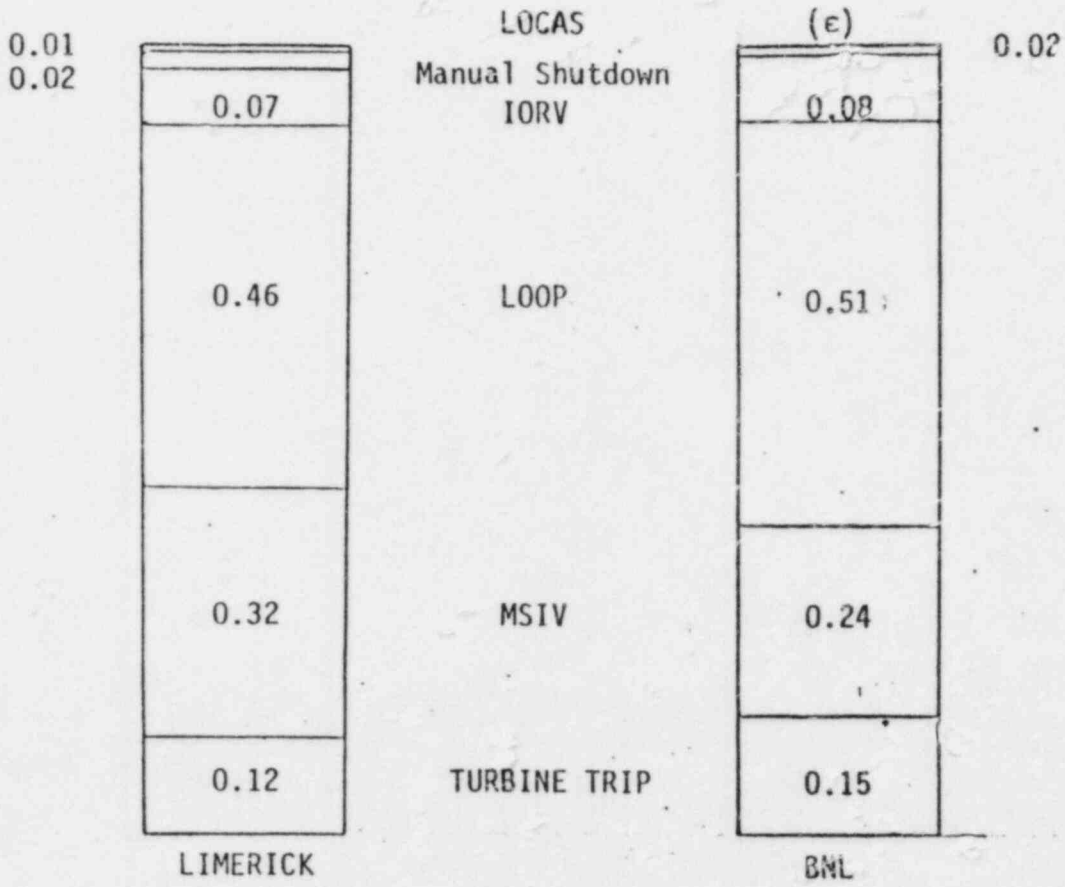
$T_E$ - Loss of off-site power
$T_F$ - MSIV Closure
$T_T$ - Turbine trip
$T_I$ - Inadvertent open relief valve
Q - Loss of feedwater and condensate system
U - Loss of high pressure coolant injection
V - Loss of low pressure coolant injection
X - Human failure of timely initiation of ADS

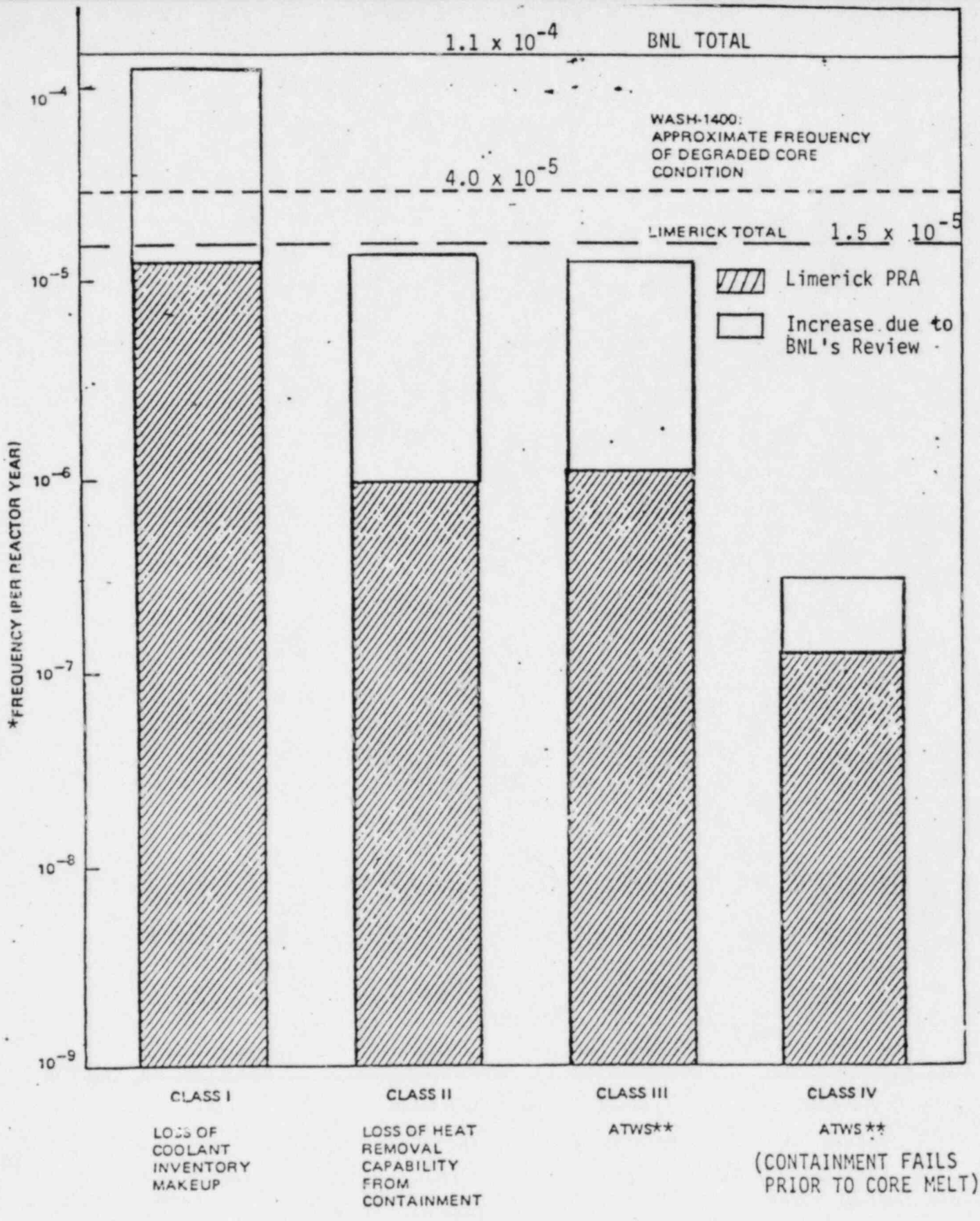



85% of $1.5 \times 10^{-5}$ 78% of $1.1 \times 10^{-4}$

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

RELATIVE CONTRIBUTION OF INITIATING EVENTS
TO TOTAL CORE DAMAGE FREQUENCY






Summary of the Accident Sequence Frequencies Leading to Degraded Core Conditions Summed Over All Accident Sequences within a Class

* Mean Frequency

**Applicant implemented ATWS alternate 3A fix as part of his PRA activities.

## MAJOR REVIEW RESULTS

## OF CONTAINMENT RESPONSE ANALYSIS

| CASE | REVIEW/RE-ASSESSMENT | IMPACT ON RISK |
|---|---|---|
| (01) | MODIFIED CONTAINMENT EVENT TREES | (A) A FACTOR OF 2 INCREASE IN MEAN ACUTE FATALITIES<br>(B) A FACTOR OF 1.7 INCREASE IN MEAN LATENT FATALITIES |
| (02) | REMOVED POOL FLASHING AT CONTAINMENT FAILURE | (A) A FACTOR OF 3 DECREASE IN LATENT FATALITIES |
| (03) | UPDATED PRA'S TREATMENT OF FISSION PRODUCT AEROSOL BEHAVIOR | (A) A FACTOR OF 3 INCREASE IN LATENT FATALITIES |
| (04) | ASSESSED EX-VESSEL CORE DEBRIS BEHAVIOR | (A) PRA POSITION IS CONSERVATIVE<br>(B) REMOVAL OF THIS CONSERVATISM MAY RESULT IN SIGNIFICANT REDUCTION IN EARLY AND LATENT FATALITIES |

# OVERALL SUMMARY OF BNL'S REVIEW

## CORE DAMAGE FREQUENCY:

- HIGHER THAN LIMERICK PRA
  (A FACTOR OF ABOUT 7 HIGHER)
- HIGHER THAN WASH-1400 BWR
  (A FACTOR OF ABOUT 3 HIGHER)

## DOMINANT ACCIDENT SEQUENCE:

- LOSS OF OFFSITE POWER FOLLOWED BY THE FAILURE OF HIGH PRESSURE AND LOW PRESSURE COOLANT INJECTION
- CONTRIBUTION TO TOTAL CORE DAMAGE FREQUENCY 42%

## DOMINANT CORE DAMAGE CONTRIBUTORS:

- LOSS OF HIGH PRESSURE COOLANT INJECTION
- HUMAN FAILURE OF TIMELY INITIATION OF ADS SYSTEM

## RISK:

- ~~MEAN EARLY AND LATENT FATALITIES OF LIMERICK ARE ALMOST SAME AS WASH-1400 BWR~~
- ABOUT 60% OF EARLY FATALITIES IS DUE TO ATWS INDUCED CORE DAMAGE IN A FAILED CONTAINMENT
- LIMERICK PRA APPEARS CONSERVATIVE IN ITS CONTAINMENT RESPONSE ANALYSIS

## STAFF'S FUTURE PLAN

(A) REVIEW BNL'S DRAFT NUREG/CR REPORT

(B) INCORPORATE COMMENTS, AS APPROPRIATE AND ISSUE A FINAL NUREG/CR REPORT

(C) FOCUS STAFF ATTENTION TO DOMINANT ACCIDENT SEQUENCES AND DETERMINE WHETHER ANY ADDITIONAL ACTIONS ARE NEEDED TO REDUCE RISK AT HIGH POPULATION DENSITY SITE SUCH AS LIMERICK

Issue #1

# CORE MELT
# DOMINANT SEQUENCES
# >80%
# UNIT 2

| IPPSS | SANDIA |
|---|---|
| SEISMIC | SEISMIC |
| FIRE | FIRE |
| HURRICANE | HURRICANE |
| TORNADO | LOCA-RECIRC. |
| LOCA-RECIRC. | CCW PIPE BREAK |
| STATION BLACKOUT (PARTIAL) | |

## UNIT 3

| | |
|---|---|
| FIRE | FIRE |
| LOCA-RECIRC. | LOCA-RECIRC. |
| | CCW PIPE BREAK |

CORE MELT FREQUENCIES

| | IPPSS INTERNAL | REVISED INTERNAL | IPPSS EXTERNAL | REVISED EXTERNAL | IPPSS TOTAL | REVISED TOTAL |
|---|---|---|---|---|---|---|
| INDIAN PT 2 | 9 (-5) | 1.9 (-4) | 3.7 (-4) | 1.3 (-3) | 4.6 (-4) | 1.5 (-3) |
| INDIAN PT 3 | 1.3 (-4) | 2.7 (-4) | 6.6 (-5) | 2.6 (-4) | 2 (-4) | 5.3 (-4) |

INDIAN PT 2

CONTAINMENT FAILURE PRIOR TO CORE MELT
INTERNAL EVENT SEQUENCES

| IPPSS | REVISED |
| --- | --- |
| • INTERFACING SYSTEMS LOCA<br>4.7 (-7) | • INTERFACING SYSTEMS LOCA<br>3.4 (-7)<br><br>• STEAM GENERATOR TUBE RUPTURE AND STUCK OPEN SECONDARY SAFETY VALVE<br>2.6 (-7) |

# INDIAN POINT 2

## CORE MELT WITH NO CONTAINMENT COOLING

| IPPSS (>95%) | REVISED (>95%) |
|---|---|
| • SEISMIC 1.4 (-4) | • HURRICANE 5.4 (-4) |
| • FIRE IN ELECTRICAL TUNNEL AND SWITCHGEAR ROOM 1.4 (-4) | • FIRE IN ELECTRICAL TUNNEL AND SWITCHGEAR ROOM 4.2 (-4) |
| • HURRICANE 2.7 (-5) | • SEISMIC 2.8 (-4) |
| • TORNADO 1.6 (-5) | • TORNADO 1.6 (-5) |

INDIAN PT 2

CORE MELT WITH CONTAINMENT COOLING

INTERNAL EVENT SEQUENCES

| IPPSS (~90%) | REVISED (~90%) |
|---|---|
| ○ LOSS OF OFFSITE POWER, LOSS OF 2/3 DIESELS, RCP SEAL LOCA, AND FAILURE TO RESTORE AC WITHIN 1 HR<br>3 (-5) | ● SMALL/MED/LARGE LOCA AND FAILURE OF RECIRCULATION COOLING<br>9.1 (-5) |
| ● SMALL/MED/LARGE LOCA AND FAILURE OF RECIRCULATION COOLING<br>3.5 (-5) | ● CCW PIPE BREAK, RCP SEAL LOCA, AND FAILURE OF HPIS<br>3.8 (-5) |
| ○ LOSS OF ALL AC, RCP SEAL LOCA, AND FAILURE TO RESTORE AC WITHIN 1 HR<br>6.5 (-6) | ● LOSS OF OFFSITE POWER, LOSS OF 2 DIESELS, RCP SEAL LOCA, AND FAILURE TO RESTORE AC WITHIN 1 HR<br>1.5 (-5) |
| ○ LARGE LOCA AND FAILURE OF LPIS<br>5.4 (-6) | ● LOSS OF MAIN FEEDWATER, FAILURE OF AFWS AND F&B COOLING<br>1 (-5) |
| | ● SMALL LOCA AND FAILURE OF HPIS<br>1 (-5) |

INDIAN PT 3

CONTAINMENT FAILURE PRIOR TO CORE MELT

INTERNAL EVENT SEQUENCES

| IPPSS | REVISED |
| --- | --- |
| ○ INTERFACING SYSTEMS LOCA<br>4.8 (-7) | ○ INTERFACING SYSTEMS LOCA<br>4.6 (-7)<br><br>○ STEAM GENERATOR TUBE RUPTURE AND STUCK OPEN SECONDARY SAFETY VALVE<br>2.4 (-7) |

INDIAN POINT 3

CORE MELT WITH NO CONTAINMENT COOLING

| IPPSS (>95%) | REVISED (>99%) |
|---|---|
| o FIRE IN SWITCHGEAR ROOM AND CABLE SPREADING ROOM 6.1 (-5) | o FIRE IN SWITCHGEAR ROOM AND CABLE SPREADING ROOM 2.1 (-4) |
| o SEISMIC 2.4 (-6) | o SEISMIC 2.4 (-5) |
| o TORNADO 9.2 (-7) | o FIRES IN CABLE TUNNEL, CABLE SPREADING ROOM, AND SWITCHGEAR ROOM 9 (-6) |
| o LOSS OF ALL AC 5 (-7) | o TORNADO 9.2 (-7) |

INDIAN PT 3

CORE MELT WITH CONTAINMENT COOLING
INTERNAL EVENT SEQUENCES

| IPPSS (~90%) | REVISED (~90%) |
|---|---|
| 0 SMALL LOCA AND FAILURE OF HPRS<br>8.2 (-5) | 0 CCW PIPE BREAK, RCP SEAL LOCA, AND FAILURE OF HPIS<br>1.4 (-4) |
| 0 MED/LARGE LOCA AND FAILURE OF LPRS<br>2.2 (-5) | 0 MED/LARGE LOCA AND FAILURE OF LPRS<br>7.8 (-5) |
| 0 LARGE LOCA AND FAILURE OF SAFETY INJECTION<br>5.4 (-6) | 0 SMALL LOCA AND FAILURE OF HPRS<br>1.5 (-5) |
| 0 SMALL LOCA AND FAILURE OF HPIS<br>2.8 (-6) | 0 SMALL LOCA AND FAILURE OF HPIS<br>1 (-5) |
| 0 LOSS OF ALL AC, RCP SEAL LOCA, AND FAILURE TO RESTORE AC WITHIN 1 HOUR<br>2.7 (-6) | 0 ATWS AND FAILURE OF F&B COOLING<br>7.4 (-6) |