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UNITED STATES ATOMIC ENERGY COMMISSION

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IN THE MATTER OF:

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
(Indian Point Station, Unit No. 2

RETURN TO REGULATORY CENTRAL FILES
ROOM 016

Docket No. 50 - 247

Place - Springvale Inn, Croton-on Hudson, N.Y.

Date - November 1, 1971 Pages 2068 - 2258

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UNITED STATES OF AMERICA

ATOMIC ENERGY COMMISSION

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In the Matter of:]

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.] Docket No. 50-247

(Indian Point Station, Unit No. 2]

= =

Springvale Inn
Croton-on-Hudson, N. Y.

Monday, November 1, 1971

The above-entitled matter came on for hearing, pursuant to notice, at 9:00 a.m.

BEFORE:

SAMUEL W. JENSCH, Esq., Chairman, Atomic Safety and Licensing Board

DR. JOHN C. GEYER, Member.

MR. R. B. BRIGGS, Member.

APPEARANCES: On behalf of the Applicant:

LEONARD M. TROSTEN, Esq., LEX K. LARSON, ESQ., 1821 Jefferson Place, N. W., Washington D.C. 20036

On behalf of the Regulatory Staff:
MYRON KARMAN, Esq., and KARL KNIEL, ESQ., Office of the General Counsel, U.S. Atomic Energy Commission, Bethesda, Maryland.

On behalf of Intervenor, Citizens' Committee for the Protection of the Environment, and on behalf of the Environmental Defense Fund:

ANTHONY B. ROISMAN, Esq., 1910 N. Street, N. W., Washington, D. C.

On behalf of the Intervenor, Hudson River Fishermen's Association:

ANGUS MACBETH, Esq., 36 West 44th Street, New York, N. Y. 10036

* * * * *

INDEX

Witness	Direct
Thomas M. Novak	2090
James S. Moore	2099

CHAIRMAN JENSCH: This proceeding is a further proceeding of the evidentiary hearing in the matter of Consolidated Edison Company of New York, Inc., in reference to Indian Point Station #2, Docket 50-247. This hearing is convened in accordance with an order convening hearings for both October 5, 1971 and November 1, 1971, setting this time and place for the convening of the hearing on November 1, 1971.

Without a detailed recitation of appearances, I notice the Applicant is represented by Messrs. Trosten and Larsen and the other gentleman--

MR. TROSTEN: The other gentleman is Mr. Edward Cohen of my office, Mr. Chairman.

CHAIRMAN JENSCH: Very well. And the Applicant is represented by Mr. Barman.

MR. KARMAN: The Staff, Mr. Chairman.

CHAIRMAN JENSCH: Excuse me. The Regulatory Staff of the Atomic Energy Commission. And the Hudson River Fishermen's Association is represented by Mr. Macbeth.

The Citizen's Fund, Environmental Defense Fund, will you please enter an appearance.

MR. ROISMAN: Mr. Chairman, my name is Anthony C. Roisman. My address is 1910 N. Street, Washington, D. C., and I represent the Citizen's Committee for the Protection of the Environment and the Environmental Defense Fund.

CHAIRMAN JENSCH: Thank you very much. State of

1 New York?

2 MR. MARTIN: Mr. Chairman, my name is Bruce L.
3 Martin. I represent the Atomic Energy Council of the State of
4 New York and my address is 112 State Street, Albany, New York.

5 CHAIRMAN JENSCH: Thank you, sir. I guess that con-
6 cludes the statement of appearances.

7 MR. ARCARO: Judge, my name is George Arcaro. I am
8 the attorney for the Citizen's League for Education about
9 Nuclear Energy, and I wonder if you would permit us to file a
10 written brief on the subject of this meeting.

11 CHAIRMAN JENSCH: Is there any objection from the
12 parties?

13 MR. TROSTEN: Mr. Chairman, I am not entirely clear
14 from what Mr. Arcaro has said as to whether he is not asking
15 for an opportunity to make a statement by way of a limited
16 appearance or exactly what the nature of his presentation is,
17 and before stating Applicant's position on this I would
18 appreciate having this matter clarified.

19 MR. ARCARO: I would be glad to submit the written
20 brief and statement that we have in mind and then possibly
21 you will be better able to decide.

22 MR. TROSTEN: Well, Applicant's position, Mr.
23 Chairman, is that if the Chairman determines it appropriate
24 and not unduly convenient from the point of the hearing
25 process to have a limited appearance statement made, then the

1 Applicant would not object to that. Beyond that Applicant
2 would object to having any further participation by a new or
3 additional party in the proceeding at this time.
4 CHAIRMAN JENSCH: As I understand it, your organiza-
5 tion formally withdrew from the proceedings, did it not?
6 MR. ARCARO: That's correct, sir.
7 CHAIRMAN JENSCH: And now you want to make a state-
8 ment by way of limited appearance, is that correct?
9 MR. ARCARO: On matters of environmental impact.
10 CHAIRMAN JENSCH: Well, you can submit your statement
11 in written form and we will give consideration to it at that
12 time. Will that be agreeable?
13 MR. ARCARO: That will be fine. Thank you.
14 CHAIRMAN JENSCH: Before we go on, there was an
15 inquiry from Congressman John Dow's office for this session
16 of the proceeding. The call came at a time during my absence
17 and I didn't get a chance to talk to the caller about it. I
18 felt that if he wanted to make a further statement or appear
19 Mr. Egan, I believe, his representative, will appear, he has
20 appeared in two previous sessions, and if he desired to make a
21 further appearance I assume following that practice he would
22 arrive here. I do not see him here now. However, we will
23 give consideration to the mater later, if he arrives.
24 The Board has received a communication from counsel
25 for the Citizen's Committee for the Protection of the

1 Environment where an indication was made as to the subjects
2 that it would desire, that the Committee would desire to
3 interrogate at this session of the hearing. Is there any
4 objection to the suggestions by the Citizen's Committee for
5 the Protection of the Environment? The Applicant?
6 MR. TROSTEN: Mr. Chairman, I have conducted dis-
7 cussions with Mr. Roisman concerning the order of presentation
8 of evidence in this proceeding. Generally speaking, the order
9 that Mr. Roisman has proposed is appropriate, but I would like
10 to have the opportunity, if I might, to have a brief con-
11 ference hearing at the outset here at which we could discuss
12 in general terms the order of proceeding for the next week.
13 CHAIRMAN JENSCH: Well, please proceed.
14 MR. TROSTEN: Yes, Mr. Chairman. I would like to
15 see the first half hour or so of this morning's session
16 devoted to a conference hearing to discuss two matters. First,
17 the basic order of procedure for the Radiological Safety
18 Hearing to be conducted in continuous sessions starting today,
19 and after we have discussed the basic order in which we will
20 be proceeding I would like to have a brief discussion with the
21 Board concerning the prospective environmental hearings on the
22 fifty per cent testing license for which Applicant has filed
23 a motion on September 24th and October 19th.
24 If this is satisfactory with the Chairman I would
25 like to proceed now to a discussion of the order in which I

propose that the hearing and Radiological Safety issues be conducted.

1 CHAIRMAN JENSCH: Please proceed.

2 MR. TROSTEN: The first matter to be taken up,
3 I would propose, would relate to the emergency core cooling
4 system issue in this proceeding. If Mr. Roisman chooses
5 to do so, we would suggest that he offer into evidence
6 the written answers to his questions of September 16
7 and October 12 which were directed to the Atomic Energy
8 Commission Staff, answers to which have just recently
9 been served upon the Board and the parties. In addition,
10 if Mr. Roisman chooses to do so, we suggest that he could
11 offer into evidence the Applicant's answers to Mr. Roisman's
12 Section C questions which were contained in his
13 September 16th letter to the Applicant and to the
14 Regulatory Staff. Following that, the Applicant is
15 prepared to offer into evidence to its question, Board
16 Question No. 5, which was raised by the Board on October 5,
17 and it pertains to the emergency core cooling testing
18 previously given. This answer would be sponsored by
19 witness Moore of the Westinghouse Electric Corporation.
20 Thereafter, we suggest that the AEC Regulatory Staff offer
21 into evidence its responses to the Board's October 5
22 question under the sponsorship of an appropriate Staff
23 witness.

24 Following those offers into evidence, we would
25 propose that Mr. Roisman proceed with his oral

1 cross-examination of the Applicant's witness and the
2 Staff's witness on matters pertaining to ECCS. We would
3 propose that Mr. Roisman first cross-examine witness
4 more on the thirty-nine questions contained in his
5 October 12, 1971 letter, and such of the questions
6 contained in his September 16 letter which he wishes to
7 address to witness Moore. Thereafter, we would propose
8 that Mr. Roisman continue his oral cross-examination if
9 he so desires of the Staff witness on ECCS matters.
10 At some point during the course of the
11 consideration of the ECCS question, Mr. Chairman, it would
12 seem appropriate that we have a discussion of the respective
13 legal positions of the parties on the matter of the status
14 of the AEC's interim acceptance criteria. I am not sure
15 of whether Mr. Roisman and I really disagree on this
16 matter or not. In any event, I think we should explore
17 this matter briefly before the Board. It may be that
18 we will have to be briefing these issues at some point
19 anyway.
20 This should complete the ECCS portion of the
21 hearing as far as the parties are concerned, Mr. Chairman.
22 I would then propose that we proceed to the matter of
23 pressure vessel integrity.
24 CHAIRMAN JENSCH: Excuse me. I thought there
25 was something circulated by the Citizen's Committee in

1 the last few days. The thought that the Citizen's
2 Committee would offer direct evidence on the ECCS --
3 MR. ROISMAN: Mr. Chairman, we did circulate
4 a paper that was prepared by the Union of the Concerned
5 Scientists, and we had hoped that we would be able to
6 present it as direct testimony, although we did not think
7 that it was absolutely critical to the case. Our problem
8 is, I think I indicated in my communications on
9 October 25th, that the same people who prepared that
10 document are now involved, also, in the Pilgrim Intervention.
11 It was a problem of whether we could have available a
12 qualified person here to sponsor it. We are not able
13 to get such a person. Therefore, we simply take the
14 statement as a statement of our position rather than
15 introducing it as evidence. We think that the statement
16 itself is not really so evidentiary. It is merely a
17 matter of drawing what we think are logical conclusions
18 from available facts. We would have preferred, if we could
19 have had the person come and sponsor it as direct
20 testimony, but that just is not possible.
21 CHAIRMAN JENSCH: Very well. Proceed.
22 MR. TROSTEN: In this connection, Mr. Chairman,
23 I ought to mention that Mr. Roisman proposes to offer,
24 by way of direct evidence, certain documents. I believe,
25 Mr. Chairman, that we need additional time before we

1 reach the question of the offer into evidence of Mr.
2 Roisman's documents. Rather than to waste a great deal
3 of hearing time, possibly arguing about the status of
4 these documents, I would prefer to discuss this with
5 Mr. Roisman to see if we could reach agreement on what
6 documents could be introduced into evidence without
7 objection. We will continue to do this and be ready at
8 an appropriate time to advise the Board when we are
9 prepared to go forward with that matter, if that's all
10 right with you.
11 CHAIRMAN JENSCH: Are you talking also about the
12 statement from the Union of Concerned Scientists?
13 MR. TROSTEN: No. There really isn't any
14 disagreement about that. Mr. Roisman isn't proposing
15 to offer that in evidence. That issue has been bypassed.
16 What I am talking about are the documents which Mr. Roisman
17 indicates he would like to have the Board take official
18 notice of.
19 CHAIRMAN JENSCH: Very well. Proceed.
20 MR. TROSTEN: After completion of the ECCS portion
21 of the hearing, I would propose that we proceed to the
22 matter of pressure vessel integrity, whatever items remain
23 to be completed. There is a written statement prepared
24 by the Staff, which I understand Staff Counsel wishes to
25 offer into evidence in this respect. There was also an

1 answer to a question raised by Board member Briggs which
2 Applicant desires to offer in evidence. As far as the
3 parties are concerned, I believe this would conclude the
4 pressure vessel aspect of the hearing.
5 The remaining items of evidentiary significance
6 are plant security with respect to which we request a
7 further in-camera session. I believe in this connection
8 that Applicant will be offering, in addition to the
9 written documents which we have already identified in
10 evidence, that we will also have additional direct
11 testimony to offer in evidence. Mr. Roisman has said
12 that he also wishes to cross-examine our witness, and he
13 will be available for this purpose. Finally there is
14 the matter of emergency plans on which Mr. Roisman has
15 indicated he wishes to cross-examine a witness from the
16 State of New York.
17 I might mention two final matters, Mr. Chairman,
18 and that is that Applicant wishes, at the conclusion
19 of this session of the hearing, to introduce in evidence
20 a letter dated October 8, 1971, from witness Cahill to the
21 Division of Reactor Licensing, pertaining to certain
22 differences between the design of the plant as depicted
23 in the FSAR and the final design of the plant as built.
24 We would also propose, at some point during the course of
25 this hearing, to introduce either as a joint exhibit or

simply to introduce for incorporation in the transcript, a stipulation executed by Applicant, the Citizen's Committee for the Protection of the Environment, the Environmental Defense Fund and the Hudson River Fishermen's Association, reflecting the agreement of these parties as to the procedural conduct of the hearing hereafter. This we would propose, Mr. Chairman, be the order for the radiological safety aspect of this hearing.

If the Board would agree with this approach or wishes to have any discussion of that, we could do that now. If not, I would be prepared to discuss the environmental aspects of this proceeding.

CHAIRMAN JENSCH: Excuse us just a moment.

(Discussion held off the record.)

CHAIRMAN JENSCH: The Board is agreeable to the suggestion of the parties as you outlined them. We will proceed further.

MR. TROSTEN: Turning now to the matter of the environmental hearing scheduled to commence approximately November 15, Applicant intends to offer in evidence its so-called additional testimony on environmental matters, which is dated October 19, 1971, copies of which have been served on the Board and the parties heretofore. This document would be sponsored in evidence by a panel of witnesses who are the following: Mr. Cahill, Mr.

1 Woodbury and Mr. Schwartz and Mr. Grob of Con Edison.
2 Mr. Lawler and Dr. Lauer, who are consultants to Con Edison,
3 and would be members of the panel discussing environmental
4 aspects of this proceeding.
5 I might mention, also, for the Board's general
6 information, if I may pull back just for a moment, that
7 in connection with the witnesses whom we have present
8 in the room, witnesses Moore and Wiesemann of the Westinghouse
9 Electric Corporation are here and intend to be here
10 through the body of the radiological hearing on ECCS.
11 We would request the Board, that if the Board desires to
12 have particular witnesses called on radiological safety
13 matters -- For example, on the pressure vessel matter,
14 any of these panel witnesses. -- we would very appreciative
15 if the Board gives us as much notice as possible, twenty-
16 four hour notice, if possible, so we could serve to
17 accommodate the Board's wishes.
18 CHAIRMAN JENSCH: The Board would endeavor to
19 do that.
20 MR. TROSTEN: As far as the environmental hearing,
21 getting back to that again, the Applicant is extremely
22 anxious, Mr. Chairman, to find out as much as we can at
23 this juncture of the Board's interests concerning
24 testimony which might be offered at the environmental
25 hearing on the fifty percent license schedule to commence

about November 15. The Applicant has offered or proposes to offer evidence on this. We propose to have our panel, whom I have identified. The Staff has filed an answer to Applicant's motion dated October 30 in which it indicates its general position and what it intends to do as far as the environmental hearing is concerned. I might add at this point that I remain exceedingly hopeful that the Staff will have completed its work well in advance of November 15th. The Staff's statement of its position on environmental matters pertaining to the fifty percent license would be available for the Board's consideration. But if the Board could identify for us at this time any areas which it felt that testimony should be offered or witnesses should be called, this would very, very significantly assist the Applicant and the other parties in preparing for the November 15 hearing.

CHAIRMAN JENSCH: I'm sure the Board will indicate to you that we will be glad to cover all the items set forth in Appendix D of the Regulations.

MR. TROSTEN: Thank you very much, Mr. Chairman.

CHAIRMAN JENSCH: You are welcome.

Did any other party desire to speak to the suggestions made by Applicant's Counsel?

MR. KARMAN: Mr. Chairman, we are rather flexible as far as scheduling is concerned. We have present here

Mr. Novak who will be our witness on ECCS matters. Our witness who will be present for the security examination and for the emergency plans is not here, but is on call. We would hope that the Board, as you indicate, will give us a reasonable time in which to get him up here.

CHAIRMAN JENSCH: We will endeavor to do that.

end

MR. KARMAN: That's all we have at this time, Mr. Chairman.

CHAIRMAN JENSCH: Very well. Any other party wish to be heard. State of New York?

MR. MARTIN: Mr. Chairman, the New York State Atomic Council will not be cross-examining or taking part in the ECCS aspect. I have some urgent business that has been brought to my attention. I am busy for the next two days and the schedule that Mr. Trosten has outlined would indicate the State's witnesses would not be required before the latter part of this week and I would request the Board's permission to be absent from the hearing during the rest of today and tomorrow and Wednesday.

CHAIRMAN JENSCH: The request is granted. You may be excused.

Any other party desire to speak to this schedule? If not, the Board will accept the suggestion of the parties with the thought that this arrangement which we understand has been discussed among the attorneys prior to today will expedite the presentation of the evidence and the bringing of this case to a conclusion. It is upon that premise that we accept those suggestions.

The Applicant, as I understand it, has offered all of the evidence that it has available in reference to the emergency core cooling, is that correct?

1 MR. TROSTEN: That is correct, Mr. Chairman, with
2 the exception of one answer to a Board question raised on
3 October 5th. If the Chairman wishes we can go over that in
4 evidence at this point, if you'd like us to do that.
5 CHAIRMAN JENSCH: Very well. Will you proceed to
6 do that, Applicant.
7 MR. TROSTEN: Mr. Chairman, as a mechanical matter I
8 will have to offer evidence that pertains not only to the
9 emergency core cooling but also to a question of Mr. Briggs'
10 pertaining to pressure vessel integrity. But I see no harm
11 in going ahead and doing that. I will identify the document
12 at this point and will ask the witnesses to swear to its
13 accuracy and will offer it in evidence. We are obtaining the
14 necessary copies now to give to the reporter so that it can
15 be incorporated into the record.
16 CHAIRMAN JENSCH: Very well, proceed.
17 MR. TROSTEN: Would witnesses Wiesemann and Moore
18 please step forward.
19 I am referring to a letter dated October 28, 1971,
20 from Applicant's counsel to the Board with copies to all
21 parties and this letter attaches a document called Answers of
22 Applicant to Questions Raised by Atomic Safety and Licensing
23 Board on October 5, 1971, Part 1. It's dated October 28,
24 1971. The first question is referred to as Question No. 1,
25 Mr. Briggs' question. The transcript reference is 1599 to

1601, and referring now to Mr. Wiesemann, may I ask you, Mr. Wiesemann, if you have reviewed this answer and specifically was this answer prepared by you or under your supervision and direction?

MR. WIESEMANN: Yes.

MR. TROSTEN: And is the answer to Mr. Briggs' question true and correct to the best of your knowledge?

MR. WIESEMANN: There is a minor typographical error in the report number.

MR. TROSTEN: Would you please identify that error.

MR. WIESEMANN: On the last line there is an extra O in the report. WCAP 7586L should be the correct wording.

MR. TROSTEN: All right.

I ask, Mr. Chairman, that this document be corrected in that fashion as received in evidence and I now--

CHAIRMAN JENSCH: It will be so understood.

MR. TROSTEN: And I now ask you, Mr. Wiesemann, if you desire to have this answer to Mr. Briggs' question received in evidence in your testimony and incorporated into the record as if read.

MR. WIESEMANN: Yes, I do.

MR. TROSTEN: Mr. Chairman, I now offer in evidence the answer to Question No. 1 of Mr. Briggs which I have just identified.

CHAIRMAN JENSCH: Very well. The request is granted

1 and the answer as identified by Applicant's counsel may be
2 incorporated in the transcript as if read.
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MR. TROSTEN: Referring now to the second attachment to this document of October 28, which is identified as Question No. 5 by Mr. Briggs, transcript reference 1615, 1616, referring now to Mr. Moore, was this answer to Mr. Briggs' question prepared by you or under your supervision and direction?

MR. MOORE: Yes.

MR. TROSTEN: And is this answer true and correct to the best of your knowledge?

MR. MOORE: Yes, it is.

MR. TROSTEN: Do you desire to have this answer received in evidence in this proceeding and incorporated into the transcript as if read?

MR. MOORE: Yes.

MR. TROSTEN: Mr. Chairman, I now offer the document which I have just identified as Question No. 5 in evidence in this proceeding and I suggest that the document be incorporated as a block, this October 28 document.

CHAIRMAN JENSCH: Well, then proceed with the other matters and we will consider it all at one time.

MR. TROSTEN: That is the extent, Mr. Chairman, of the additional testimony on ECCS matters.

CHAIRMAN JENSCH: Very well. Is there any objection to the request of the Applicant's counsel?

MR. KARMAN: No objection, Mr. Chairman.

MR. ROISMAN: No objection.

MR. MACBETH: No objection.

CHAIRMAN JENSCH: Hearing no objection request is granted and the answer identified by Applicant's counsel may be incorporated within the record as if read.

Does that conclude your offer?

MR. WIESEMANN: It does, Mr. Chairman.

(Document follows.)

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October 28, 1971

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Re: Consolidated Edison Company
of New York, Inc.
Indian Point Unit No. 2
AEC Docket No. 50-247

Gentlemen:

There is enclosed a copy of answers to two of the questions raised by members of the Atomic Safety and Licensing Board at the hearing session on October 5, 1971. Applicant intends to offer these answers in evidence at the coming session of hearings.

Very truly yours,

LEBOEUF, LAMB, LEIBY & MACRAE

By Leonard M. Trosten
Leonard M. Trosten
Partner

Enclosure

cc: Myron Karman, Esq.
Anthony Z. Roisman, Esq.
Angus Macbeth, Esq.
J. Bruce MacDonald, Esq.
Honorable Louis J. Lefkowitz
Secretary, USAEC
Algie A. Wells, Esq.

BEFORE THE UNITED STATES
ATOMIC ENERGY COMMISSION

In the Matter of	)	
Consolidated Edison Company of New York, Inc. (Indian Point Station, Unit No. 2)	)))	Docket No. 50-247

Answers of Applicant to Questions Raised

by Atomic Safety and Licensing Board

on October 5, 1971

Part I

October 28, 1971

KEY TO QUESTIONS

(B) - Mr. Briggs' Questions

(J) - Chairman Jensch's Questions

The questions have been numbered as follows:

1. Mr. Briggs' question regarding effect of transient on reactor vessel integrity (Tr. 1599-1601)

2. Mr. Briggs' question regarding Staff's check of Westinghouse's ECCS calculations (Tr. 1612)

3. Mr. Briggs' question regarding independent temperature calculation for most severe loss-of-coolant accident (Tr. 1613)

4. Mr. Briggs' question regarding calculation of temperatures by the RELAP Code (Tr. 1613)

5. Mr. Briggs' question regarding assumption of no steam flow through unbroken lines (Tr. 1615-1616)

6. Mr. Jensch's question regarding dissolved oxygen content in the river (Tr. 1616-1618)

Question No. 1 (B) (Tr. 1599-1601)

"Well, we have indicated then that you gentlemen can conclude that the flaws in the reactor vessel, if there are any, any of any significance, it would be highly unlikely that they would be more than half an inch deep by several inches long, and you also conclude, I believe, that a flaw this size would not be sufficient to cause failure of the reactor vessel under the conditions that are imposed by the technical specifications.

"There was a calculation requested, I believe, by the ACRS concerning the situation if there were a transient and the rods failed to drop, in which case, if I recall, the pressures in the reactor vessel would go as high as about 4000 psi. Is this number right? Do you recall the calculation?

"Would you, before the next session that we have, look at that situation and indicate whether the conditions imposed on the reactor vessel by that transient would change any of the statements that you have made in the report here? I don't ask you to do it now. Unless someone is completely familiar with those numbers, that is.

"This additional testimony doesn't include an examination of that transient. There was consideration given when the transient was examined in your other reports of what these vessels would be and whether the reactor vessel would fail. I'd like for you to look at the case of that transient again, the conclusions reached then and what is stated in this report, and see if there is anything different that you put in this report as a result of the conditions that exist in that transient.

"In other words, it is a case that wasn't considered here. I would like to have it looked at again."

Answer:

We have reviewed the analysis and conclusions reported in FSAR Response to Question 14.7 and in Westinghouse Proprietary Report WCAP 74860L to which we assume Mr. Briggs referred. We

Q. 1 (B) (Tr. 1599-1601)

find nothing which changes any previous testimony regarding the integrity of the reactor vessel at Indian Point Nuclear Generating Station Unit No. 2.

Question No. 5 (B) (Tr. 1615-1616)

"[W]hat would the situation be if one changed his assumption so if steam flowed through all four lines and the accumulator water that was entrained in the thing be carried out through the broken loop? In other words, one can make two kinds of assumptions: He can make the assumption that is made in the calculations that there is no steam flow through the three unbroken lines, that the accumulator water that comes into those lines goes into the space around the core barrel and is available at the core; he can make the other assumption that there is steam flow through those lines and that some of the accumulator water is entrained in the steam and is carried out the break. I'd like some discussion about which of these assumptions is the more conservative, and whether there is reason, really good reason for the assumption that is used here rather than the assumption of entrainment of accumulator water in the steam and this water being carried through."

Answer:

The assumption of no steam flow through the unbroken lines during accumulator injection is conservative since steam flow is prevented through the 3 unbroken lines thus greatly reducing the fuel rod heat transfer.

If steam flow is considered to exist through the unbroken lines, the interaction between steam and water in the cold leg pipe will condense the steam thus reducing the pressure and the steam flow velocity. This effect will result in an increased core reflooding rate. Should the liquid be partially entrained by the steam flow, it will separate from the steam in the downcomer region due to the flow area increase, the change in flow direction, and the pressure of the hot leg nozzles.

Q. 5 (B) (Tr. 1615-1616)

It follows that the assumption of no steam flow through the unbroken lines and the associated low values of heat transfer in the core is more conservative, and is the assumption made in the analysis.

CHAIRMAN JENSCH: Staff?

MR. KARMAN: Yes.

Mr. Chairman, at this time I wish to have Mr. Thomas M. Novak sworn in as a witness for the Staff.

CHAIRMAN JENSCH: Mr. Novak, would you stand and raise your right arm.

(Thomas M. Novak, Sworn.)

CHAIRMAN JENSCH: Will you have a seat, please.

MR. KARMAN: Thank you, Mr. Chairman.

Mr. Novak, did you prepare a statement of your professional qualifications for this hearing?

MR. NOVAK: I did.

MR. KARMAN: Do you have any corrections or annotations to such statement?

MR. NOVAK: No. No, I don't.

MR. KARMAN: Is this statement of your professional qualifications true to the best of your knowledge?

MR. NOVAK: Yes.

MR. KARMAN: And do you adopt it as part of your testimony in this proceeding?

MR. NOVAK: Yes.

MR. KARMAN: Mr. Chairman, at this time I offer into evidence the statement of professional qualifications of Mr. Thomas Novak and request that it be incorporated in the transcript as if read. It has been previous ly distributed to the Board and all parties.

CHAIRMAN JENSCH: Yes. Any objection? Hearing no objection, the request is granted and the statement of professional qualifications of witness Novak will be incorporated in the transcript as if read.

(Statement of qualifications follows.)

THOMAS M. NOVAK
PROFESSIONAL QUALIFICATIONS
PRESSURIZED WATER REACTOR PROJECTS BRANCH NO. 4
DIVISION OF REACTOR LICENSING

I am employed as a senior project leader in the Pressurized Water Reactor Projects Branch No. 4, Division of Reactor Licensing. My responsibilities include performing safety reviews and evaluations of nuclear power plant construction permit and operating license applications.

I graduated from Rutgers University in 1958 with a Bachelor of Science degree in Mechanical Engineering. In 1968, I received a Masters degree in Mechanical Engineering from Catholic University of America.

In June of 1958, I joined the Westinghouse Electric Corporation and participated in the Graduate Student Training Program. In November of 1958, I accepted a permanent assignment at the Bettis Atomic Power Laboratory, West Mifflin, Pennsylvania. While at the laboratory, I worked in a section responsible for thermal and hydraulic design of submarine reactor cores. As a member of this section, I performed design and accident analyses for a variety of core designs. Prior to leaving the laboratory, I was assigned project responsibility for a series of tests to determine departure from nucleate boiling and pressure drop characteristics for a potential fuel element configuration.

In November of 1964, I undertook employment with the U. S. Marine Engineering Laboratory, Annapolis, Maryland. As a senior project engineer I was given the responsibility for developing and carrying out R&D programs for improving the performance of naval steam generators. My duties included

supervising the design, construction, and operation of high pressure heat transfer and water treatment test loops. I supervised the development of computer codes to predict steady-state and dynamic thermal performance characteristics of naval propulsion boilers involving both pressure-fired and forced-draft systems.

In November of 1968, I accepted a position with the Division of Reactor Licensing. Since joining the Commission, I have participated in the review of the Westinghouse Merchant Ship Reactor proposed for the Maritime Administration and was assigned as the project leader for the safety evaluation of the Sequoyah Nuclear Plant. I was assigned as the project leader for the operating license review of the Zion Station Nuclear Plant.

In March 1971, a Regulatory Task Force consisting of senior regulatory management and chaired by Dr. S. H. Hanauer, Technical Advisor to the Director of Regulation, began a comprehensive review of ECC systems for light water reactors. Additional regulatory personnel were assigned to the Task Force specifically for the ECCS reappraisal effort. Because of my experience in the technical evaluation of ECCS performance in connection with the DRL review of several pressurized water reactors I was one of those assigned to the Task Force. My activities in connection with the ECCS reappraisal included attendance at nearly all of the Task Force meetings, trips to the PWR vendor offices, and trips to the Aerojet Nuclear Corporation offices and experimental facilities. I have reviewed and discussed with the Task Force the ECCS analyses performed and reported by the PWR vendors and the results of experiments associated with ECCS performance.

On June 19, 1971, the Atomic Energy Commission adopted an interim statement of policy providing interim acceptance criteria for ECCS for light water power reactors. I have participated in the re-evaluation of ECCS performance for the Palisades Nuclear Plant and the Indian Point No. 2 Nuclear Plant as required by that statement.

MR. KARMAN: Mr. Chairman, on September 3rd I forwarded to the Board and to all parties copy of a document entitled Supplement No. 3 to Safety Evaluation by the Division of Reactor Licensing U.S. Atomic Energy Commission in the Matter of Consolidated Edison Company of New York Inc., Indian Point Nuclear Generating Unit No. 2, Docket No. 50-247. Mr. Chairman, I would appreciate at this time if I could take this safety evaluation and a few subsequent responses and have them put in all at the same time.

CHAIRMAN JENSCH: Very well. Will you proceed.

MR. KARMAN: Fine. Thank you. I now offer responses and comments of the AEC Regulatory Staff to the questions asked by the presiding Atomic Safety and Licensing Board entitled Additional Testimony of Applicant Concerning Reactor Vessel Integrity.

We had an understanding, a stipulation between the Applicant, the Staff and the Counsel for the Intervenors, that they would waive the necessity of having present today those parties in the Atomic Energy Commission Regulatory Staff responsible for formulating the responses on pressure vessel integrity. We will, if absolutely necessary, Mr. Chairman, or if any members of the Board feel it essential that further questioning be had with any of our staff, that we be given a reasonable time to

1 get them before such question.

2 CHAIRMAN JENSCH: We will endeavor to do that.

3 MR. KARMAN: Thank you, Mr. Chairman.

4 I now offer responses of the Atomic Energy
5 Commission's Regulatory Staff to questions asked by the
6 presiding Atomic Safety and Licensing Board at the hearing
7 session of October 5, 1971. Again, all of these matters,
8 all of these documents, have been served on the Board
9 and the parties to this proceeding.

10 Mr. Novak, I ask you whether you participated
11 in the preparation of the Supplement No. 3 to the Safety
12 Evaluation just mentioned and of the responses of the
13 Staff to the Board questions of October 5, 1971?

14 MR. NOVAK: I did participate.

15 MR. KARMAN: Are there any corrections or
16 additions you wish to make in either or both of these
17 documents?

18 MR. NOVAK: Yes. There is one correction I
19 wish to make to the Supplement of the Safety Evaluation.
20 The change would appear on page nine and I would like to
21 replace the item No. 3 appearing at the top of the page
22 with the following statement.

23 No. 3. The Commission's iterim policy statement --

24 CHAIRMAN JENSCH: Will you go slowly. We are
25 going to try to take it down too so we will have it in our

notes. Would you proceed slowly.

MR. NOVAK: I will start over again.

CHAIRMAN JENSCH: Please.

MR. NOVAK: No.3.

The Commission's interim policy statement Appendix A required that an acceptable evaluation model use the decay heat curve described in the proposed ANS standard with an added twenty percent allowance for uncertainty. The decay heat rate used by Westinghouse in its earlier analysis of the Indian Point 2 plant had an error resulting in a greater contribution to the residual decay heat from the heavy element uranium 239 and neptunium 239, decay of neutron- captured products.

Correcting this error and following the Commission's interim policy statement resulted in a decay heat slightly lower than the earlier prediction. A decrease was also made in the heat deposition in the hot rod from 97.4 percent to 95 percent for the analysis of loss of coolant accident.

That ends the correction.

CHAIRMAN JENSCH: Will you give it to us in typewritten form, too, so we may have it? Do you have an extra copy of what you were reading?

MR. NOVAK: No, I don't.

MR. KARMAN: We will endeavor to have a copy

1 made for the Board.

2 CHAIRMAN JENSCH: It's easier. We'd like to

3 have it for our notes rather than waiting for the

4 transcript.

5 MR. KARMAN: We will get that for you.

6 CHAIRMAN JENSCH: Thank you.

7 MR. KARMAN: Mr. Novak, are the contents of

8 the Safety Evaluation Supplement No. 3 and the responses

9 of the Staff to the Board questions of October 5 as

10 corrected true and correct to the best of your knowledge?

11 MR. NOVAK: Yes, they are.

12 MR. KARMAN: Do you adopt these as part of your

13 testimony in this proceeding?

14 MR. NOVAK: I do.

15 MR. KARMAN: Mr. Chairman, I offer these three

16 matters as Supplement No. 3, the responses to the pressure

17 vessel questions, and the responses to the questions of

18 the Board of October 5, 1971, into evidence.

19 CHAIRMAN JENSCH: Is there any objection?

20 MR. TROSTEN: Mr. Chairman, with respect to

21 the pressure vessel integrity testimony, Applicant has

22 just received very recently that testimony and we are

23 still in the process of looking at it. I would request

24 that the receipt into evidence of a pressure vessel

25 integrity matter be temporarily deferred -- I think that

1 we can resolve this matter very quickly -- until
2 Applicant has had an opportunity to study the matter more
3 closely. With respect to the additional testimony just
4 offered today by Mr. Novak I similarly would like to have
5 an opportunity to scrutinize that testimony before
6 the document is actually received in evidence.
7 As an alternative, if the Chairman wishes,
8 it could be received subject to a motion to strike. But
9 I suggest the first approach.
10 CHAIRMAN JENSCH: Well, I think ordinarily that
11 no evidence should be received until the parties have had
12 a chance to view it. On the other hand, anything that is
13 received is subject to a motion to strike if it is
14 believed that a basis exists for it.
15 But do the October 5 answers cover several
16 subjects?
17 MR. KARMAN: None. These are ECCS questions.
18 CHAIRMAN JENSCH: All October 5 answers are
19 ECCS?
20 MR. KARMAN: Yes.
21 MR. TROSTEN: Mr. Chairman, my problem is not
22 with the October 5 answers, really. It's simply with a
23 limited portion of the pressure vessel integrity statement
24 and with the document that Mr. Novak was just reading
25 this morning, which frankly I haven't been able to grasp

by just listening to it.

CHAIRMAN JENSCH: Yes. Well, let us defer rulings and when we reach the point of examining the Staff evidence we will give consideration to its receipt.

MR. TROSTEN: Thank you, Mr. Chairman.

CHAIRMAN JENSCH: Very well. The request of Counsel is granted.

Does that bring us into the point of cross-examination? I am afraid we are. And does the Staff have an interrogation of the Applicant's witnesses on emergency core cooling?

MR. KARMAN: We have no questions on that, Mr. Chairman.

1 CHAIRMAN JENSCH: Well, which of the Intervenors
2 desires to go forward first, Hudson River Fishermen's
3 Association or the Citizen's Committee?
4 MR. ROISMAN: Citizen's Committee, Mr. Chairman.
5 The procedure that we would like to follow, if this
6 is acceptable to the Board, and what we suggested in our
7 October 25th document was that Mr. Moore simply take the ques-
8 tions which we submitted to the Applicant and the Staff on
9 October 12th of 1971, and excluding Question No. 1 unless he
10 wishes to comment on that, it deals with a matter which we
11 have been in discussions with the Staff about, begin with
12 Question No. 2 through Question No. 39 and simply read the
13 question as though I had asked it orally and then read into
14 the record his answer thereto. And when that is completed
15 we'd like an opportunity overnight, that is, from the time he
16 completes that until the following morning, to then prepare
17 cross-examination based upon the information that he provided.
18 Our thought was that this would get us to the November 1
19 hearing withough having to worry about written answers to the
20 questions, and that we could use the transcript as our written
21 answer. So that basically what I am suggesting is that Mr.
22 Moore give us a soliloquy this morning, and that I would not
23 interrupt that even thought I might have a question to ask
24 about it, but wait until I studied the answers and then ask
25 him the questions tomorrow.

CHAIRMAN JENSCH: Is there any objection to that, Applicant's counsel?

MR. TROSTEN: No.

CHAIRMAN JENSCH: Mr. Moore, would you come forward, please.

(The witness Moore takes the stand.)

CHAIRMAN JENSCH: Do you have the question before you and can you proceed in line with the suggestions which have been made for answers? Will you do so, please.

MR. TROSTEN: Mr. Moore, do you have Mr. Roisman's October 12 letter before you?

MR. MOORE: Yes, I do.

CHAIRMAN JENSCH: Does anybody have an extra copy of the October 12 letter?

MR. ROISMAN: It's not extra.

CHAIRMAN JENSCH: Well, if you need it for your examination. Maybe the Staff has a copy.

MR. ROISMAN: I'm planning just to listen.

CHAIRMAN JENSCH: We find we do have copies and thank you very much.

Will you proceed, Mr. Moore.

MR. MOORE: Beginning with Question 2. The question was, "What are the assumptions ans figures used and the basis for their usage with respect to both transient pressures and the amount of water remaining in the vessel after blowdown as

a function of time?"

The transient pressures under water remaining in the vessel after blowdown are calculated using our Satan digital computer code. This calculation is described in our July 13th, 1971 testimony. With the Satan code the vessel is essentially dry at the end of the blowdown. There is essentially no residual water left in the vessel. The transient pressures are calculated throughout the system using the Satan code.

Question 3. "What affect does the failure of RELAP 3 to predict pressures within 100 psia of those actually measured (See In-1444, Page 13) have on the reliability of the ECCS prediction for this plant? How has this problem been corrected in the Staff and Applicant analysis?"

This question was or will be answered by the Staff. I have no additional comments on that.

Question No. 4. "Discuss the assumptions used and the basis for them with respect to the critical flow phenomenon and its effect on the rate at which coolant is expelled from the core in a loss of coolant accident."

The approach we used is described in our emergency core cooling performance report dated June 1, 1971, Section 6.4. This approach is also referenced in the interim policy statement appendix A, Part 3. Basically we use emperical correlations which have been developed to calculate the discharge flow from the reactor coolant system as a function of time and pressure in the primary system.

end

1 These empirical correlations tend to overpredict
2 the discharge flow from the reactor coolant system, and
3 in order to really determine the expected discharge
4 from the system, one has to apply correction factors,
5 commonly termed as discharge coefficients. As explained
6 in our previous testimony, we had used a discharge
7 coefficient of 1.0 for the correlations that we used,
8 and this overpredicts, then, the release of discharge of
9 coolant from the primary system in a conservative direction
10 with respect to the performance of the emergency core
11 cooling system.
12 Question 5 I had some difficulty with the word
13 "conical." Whether that was a typographical error or
14 that was the intent of the question --
15 MR. ROISMAN: It was not a typographical error.
16 I don't have my original note here, but that is what I
17 intended.
18 MR. MOORE: Reading the question, "Explain
19 the use of a conical approach for determining the critical
20 discharge of steam water mixture from a broken pipe. What
21 other approach can be used and how will this affect
22 blowdown and ECCS performance?
23 I have interpreted this as a question regarding
24 the physical geometry of the break, and whether there is
25 a tapered or divergent discharge, or whether it is a

1 discharge from an abrupt pipe ending, and how this might
2 affect the discharge rate from the steam. As indicated
3 on testimony, we used a correlation which is based on
4 the flow which you would get from an abrupt pipe. There
5 have been data obtained for discharges from pipes which
6 have divergent discharge nozzles. The data indicates
7 that the discharge flow is actually less than that which
8 you would obtain from an abrupt pipe. Therefore, our
9 correlations which are based on the abrupt pipe and which
10 do overpredict a discharge flow, are conservative with
11 respect to any kind of a divergent nozzle.
12 Question No. 6, "To what extent has the
13 Fauske Theory been used in determining critical flow and
14 in what manner have the Fauske Theory inadequacies
15 in predicting secondary choking been corrected? The
16 HW-80535 (page fourteen)."
17 The Fauske Theory is not used in our core
18 cooling analyses. We use the Moody Correlation, and
19 therefore there are no corrections per se required with
20 respect to the Fauske Theory.
21 Question No. 7, "In light of recent semi-
22 scale tests and the level of steam pressures produced,
23 explain the manner in which the ECCS analysis takes account
24 of the higher metal water reaction when high steam pressures
25 and high water temperatures exist. See ANL-6548, page ten,

1 sixteen."

2 As described in our July 13th testimony on
3 page fifteen, the heat generation due to the certain water
4 reaction is continuously calculated during a transient.
5 It is calculated as a function of time and the oxide
6 thickness as a function of time. We use a parabolic rate
7 relationship, which has been derived from experimental
8 data, to relationship derived by Baker and Just. We use
9 this parabolic rate relationship even during the adiabatic
10 heat-up of the transient where there may not even be
11 sufficient steam or water in the system to create that
12 extensive a reaction, water reaction.

13 So we have a conservative upper calculation
14 for the total water reaction.

15 The effects of the oxide layer on heat transfer
16 are also taken into account with respect to the temperature.
17 The correlation employed is presented in ANL-6548.

18 Question No. 8, "In light of the fact that
19 small particles of metal have higher metal-water reactions
20 (ANL-6548, pages ten, twelve, fourteen) how does the
21 computation of the metal-water reaction take into account
22 clad fragments and rough edges as a result of clad bursting.
23 Use ORNL-4635 statistic for the quantity of clad bursting
24 which will occur in a LOCA but indicate the additional
25 number of burst rods which reach temperatures of 1800 degrees

Fahrenheit to 2300 degrees Fahrenheit."

The small particles of metal which could be exposed, or the rough edges which could be exposed as a result of clad bursting are not directly taken into account in determining the total metal-water reaction in the core. This is because they represent a very small fraction of the total surface of the core, and as indicated in previous testimony, the total core wide Zirc water reaction is well below the one percent limit. In fact, it is less than .07 percent. Therefore, an additional small amount of reaction which might occur because of the additional exposed area with rod burst is a very small addition to the total core wide reaction, which in itself is a very small number compared to the one percent limit.

Question No. 9, "Does the one per cent of metal-water reaction mean one per cent of the total volume of Zirconium or only one per cent of the total surface area of Zirconium exposed to water? Justify the former definition if it is used."

The metal-water reaction is described as a percentage of the total mass or volume of the core. All surface areas are considered in determining the total contribution of metal-water reaction.

Question 10, "Discuss the manner in which the heat generated by the metal-water reaction is taken into account in computing pear clad temperatures. For instance, where in the core is the reaction assumed to occur and how is the higher heat created at that spot added into calculated rod temperatures. Also, how is the higher fuel rod temperature caused by the metal-water reaction taken into account in predicting the rate of further metal-water reaction. Refer to ANL-6548, Page 58."

As I indicated in an earlier answer, the metal-water reaction is continuously calculated throughout the core as a function of temperature and the amount of oxide thickness as obtained. It is calculated throughout the trangients for both the hot spot and also other regions of the core. Then the total contribution of metal-water reaction is added up. The clad temperature is based, then, on the amount of heat generation from the reaction which is added to the cladding

and which then has to be transferred from the cladding through the oxide thickness to the cooling water or steam-water mixture in the core.

Question 11, "How is the metal-water reaction affected by the presence of irradiated fuel rods, how have these effects been included in the analysis and upon what experiments are the computations made? Describe the experiments and the conditions under which they were performed."

The presence of irradiated rods per se does not affect the metal-water reaction. You don't get a different metal-water reaction because the rods have irradiated.

Question 12, "What percentage of metal-water reactions has been predicted for each temperature level in the reactor. What percentage of fuel rods and how much of the rods will reach each of those temperatures? Describe the method by which it has been determined that a metal-water reaction will be less than one per cent. Answer this question in light of the experimental results from the ORNL-4635 showing 0.2 per cent metal-water reaction for rods at or below 1800 degrees Fahrenheit with only one irradiated rod and that rod irradiated for only thirty days. See ORNL-TM-3188, Pages 17, 20. Also consider the effect of the movement of the steam-water mixture on the reaction. See ANL-6548, Page 50."

As I indicated previously, the amount of metal-water reaction that one obtains is a function of both temperature and

1 the time at which you are at these different temperatures.
2 Our LOCTA R2 code is used to calculate the temperature as a
3 function of time and to determine the total amount of certain
4 water reaction assuming the parabolic rate law.
5 The core is divided into various regions which have
6 the same power in order to calculate their contribution to the
7 total corewise metal-water reaction.
8 As I indicated from a corewise basis, there is much
9 is much less than one per cent total metal-water reaction.
10 The fraction of cladding which is greater than 1800 degrees or
11 reaches greater than 1800 degrees Fahrenheit during the
12 transient, is less than two per cent of the total core volume.
13 So you can see why the total corewise metal-water reaction is
14 quite small. The specific experiment referenced in ORNL-4635
15 were two-tenths of a per cent reaction as obtained with a
16 temperature of 1800 degrees Fahrenheit and is somewhat suspect
17 in that it is an implied reaction based on the amount of
18 hydrogen released, which is determined by taking a total amount
19 of non-combustible gas which was obtained from the experiment,
20 and subtracting a large amount of this, a large fraction of
21 this, which was helium, and the remaining hydrogen then was
22 assumed to occur for metal-water reaction, and in the report
23 there is actually stated an accuracy on that figure of 22%,
24 of plus or minus 50%.
25 The metal-water reaction relationship we use in our

analysis are based on a considerable amount of experimental data. I think the parabolic rate equations have been substantiated by several experimentors.

Question 13, "How is the temperature level for each rod computed? What simplifying assumptions are used?"

The temperature of the rod and the cladding is computed using the LOCTA R2 code. This code uses hydraulic input on the Satan code. That is flow, inlet temperatures, pressure and quality. It divides the core into radial region and axial sections and performs finite difference, conduction, involves finite difference conduction equation in the radial direction. The Zirc water, parabolic rate equations included in the calculation and the heat transfer is established as a function of local coolant flow, quality and temperature conditions, so that a continuous time varying temperature is calculated throughout the loss of coolant transient. Various regimes of heat transfer are considered in the analysis, including single phase convective cooling, nuclear boiling, transition boiling, et cetera.

The internal pressure and the rod between the cladding and the UO2 is calculated as a function of time and cladding thermal expansion is calculated. Internal heat generation is included in the analysis obtaining from delayed fission and residual heat generation. The Zirc water reaction energy is added directly to the cladding.

1 Question 15, "Discuss the use of the parabolic
2 rate law in computing the amount of metal-water reaction."
3 As I previously indicated, this is a relationship
4 which was developed by Baker and Just at the Oregon
5 National Laboratory. The rate of reaction is assumed
6 to be a diffusion process which varies inversely with
7 the thickness of the oxide layer, and also has a
8 temperature dependent that accelerates the reaction of
9 higher temperatures. These are both accounted for in
10 the parabolic rate equation.
11 As I indicated previously, we do not take into
12 account the fact that we may not have enough steam or
13 water available to get the complete reaction we have
14 assumed. The parabolic rate law assumes an unlimited
15 source of steam-water to react.
16 Question 16, "To what extent and in what manner
17 have other chemical reactions been considered in computing
18 the core heat? For instance, discuss the metal-water
19 reaction associated with the maximum Zirconium alloy
20 discussed in ANL-6548, pages 51-52, the reaction with
21 uranium dioxide and water and the reaction between the
22 eutectic formed by iconel (in the spacers) and zircalloy
23 and water discussed in IN-1453."
24 The effect of eutectic reactions and the other
25 chemical reactions on clad heat-up were found to be

1 negligible. The reference to uranium-zirconium alloy
2 refers to a fuel alloy not the uranium oxide cladding
3 situation we have. The eutectic formed by iconel grids
4 in the cladding has been considered and tests have been
5 performed and determined that this eutectic does exist
6 with a melting temperature of about 1760 degrees Fahrenheit.
7 This is a eutectic formed between the zirconium and nickel.
8 However, the tests showed that even at temperatures of
9 2300 degrees, should they exist for several minutes, did
10 not disturb the coolant flow area.

11 There was evidence of a reaction, some local
12 melting at the point of contact of the grid with the rod.
13 However, the rod did not fuse to the grid nor were droplets
14 or sputtering detected which could block the coolant flow
15 area. These tests were run under more severe conditions
16 than expected during the loss of coolant accident.

17 Question 17, "To what extent does the pressure
18 of rod spacers tend to concentrate metal-water reactions
19 and rod swelling and bursting at or near the spaces? To
20 what extent has this factor been included in the FLECHT
21 tests and other rod performance tests relied upon in
22 the analysis of this reactor? See ORNL-TM-3188, page
23 fourteen."

24 As I indicated in the previous answer, there
25 is a negligible effect of the spacer on the rod. This is

1 primarily because the heat is conducted away from the
2 contact points very easily, and hot spots are not formed
3 at the locations where the spacer contacts the rod.
4 Spacers were incorporated in the FLECHT test bundles and
5 test rod integrity was maintained.
6 Question 18, "Discuss the assumption that
7 core geometry will remain intact and not interfere with
8 ECCS performance in light of the statement in ORNL-TM-2742,
9 page 1-2."
10 This Oak Ridge report written in January 1970
11 discusses some proposed multi-rod burst tests to determine
12 the behavior of cladding, in rod bundles under loss of
13 coolant conditions. The expressed concern was whether
14 or not we could have rod deformation sufficient to
15 seriously block the cooling channels in the fuel assemblies
16 and lead to possible failure of the ECCS system performance.
17 As I said, this report was written back in
18 January 1970. These concerns were recognized. In
19 addition to the Oak Ridge tests, Westinghouse also was
20 performing similar multi-rod burst tests which have been
21 described or presented as part of the testimony for the
22 Indian Point - 2 operating license. These were multi-rod
23 burst tests where we did determine the extent of flow
24 blockage that one could obtain as a result of these clad
25 failures. Then their effect on heat transfer was

determined by running FLECHT heat transfer tests with varying amounts of blockage. This particular concern referenced in January 1970 was being addressed, and in fact results of experimental programs have shown that the flow blockage that could be obtained from rod deformation does not seriously impair the ECCS performance.

Question 19, "Does the analysis of post-LOCA rod swelling include possible 60 percent of expansion of the rod? See ORNL-TM-2742, page 5, In this answer, fully discuss the interaction between creating rate, internal pressure, ductile behavior and the effect of these factors on whether a rod will burst after only a little swelling or burst only after substantial swelling. See ORNL-TM-3188, page 11-13. Explain how these variables are taken into account in the analysis of rod performance after an ECCS. Explain how the tests used to verify rod performance have included the important factors which will influence the extent of rod swelling before bursting. See ORNL-TM-2742, pages 6-7, 10, 14-15 on the latter pages. Please answer the questions shown there."

Simulated loss of coolant tests have been carried out by Westinghouse, and the results and analysis presented in reports both single rod burst tests and multi-rod burst tests. Concerning the possible sixty percent expansion, our results in the analyses of these

results do consider fuel rod expansion of sufficient magnitude to block a channel. In particular, our results from our tests showed that the multi-rod test program covered the range of differential pressures and heat-up rates of prime interest for a loss of coolant accident in a PWR.

The result of the test indicate that fuel rods burst in a staggered manner so that the maximum average assembly was flowarea blockage does not exceed about 50%. Localized rod to rod contact is observed at several locations in the assembly. For these regions, even assuming no convective heat transfer in the region of rod to rod contact, the maximum calculated heat clad temperature increases only 70% Fahrenheit. The spectrum of conditions covered in these tests bracket those expected in the loss of coolant accident.

For example, heating rate, internal pressure. These were included in the tests to determine the important parameters that influence the extent of rod swelling before bursting. So the values that we used in the analysis of the effective rod bursting are considered to be typical of those that could obtain in a loss of coolant accident.

Question No. 20, "In the staff analysis of rod burst tests by suppliers, what inadequacies were found that warranted the conduct of additional tests by ORNL?"

We know of no inadequacies that prompted the performance of the Oak Ridge tests. But this is a question that also is being answered by the Staff.

Question 21, "On Page 22 of ORNL-TM-2742, several factors present in the ORNL rod experiments are listed. Compare and contrast these to the factors present in the rod test relied upon by Applicant."

The same variables listed on Page 22 of the reference report were incorporated in our Westinghouse test, namely, the effects of internal pressure, plenum volume and heating rate.

Question 22, "Discuss the extent to which rod tests have included the effect of irradiated rods on test results particularly the higher burning levels associated with this reactor. See ORNL-TM-2742, Page 39."

As reported in our WCAP-7379, Volume 2, rod burst tests were performed on irradiated rods simulating the loss of coolant accidents. The results of these tests showed that there was not any real difference between the burst characteristics of an irradiated rod versus an unirradiated rod.

Question 23, "Explain how the concerns expressed in ORNL-TM-3188, Page 2, are resolved for this plant."

The concerns expressed on Page 2 relate to possible embrittlement of the Zirc cladding as the result of reaching high temperatures for extended periods of time where you get a large amount of metal-water reaction. Should the rods become embrittled, then upon subsequent cooling with the emergency core cooling system, it is postulated that these rods could fail in a brittle manner and you would no longer maintain a cooling geometry for the core, a coolable geometry for the core.

These concerns have been taken into account and tests have been performed by Westinghouse as well as other

1 manufacturers of the AEC to determine what are the limits for
2 temperature and Zirc water reaction with respect to possible
3 embrittlement of the cladding.
4 As indicated in our testimony, the tests results
5 show that the maximum value of the extent of metal-water
6 reaction that we obtain for our analyses is well below the 16%
7 upper limit which was determined from tests of cladding which
8 were heated to high temperatures and allowed to react and
9 subsequently cooled, and their embrittlement characteristics
10 determined.
11 So this particular question, which was raised in
12 early 1970, has been addressed and is reflected in our core
13 cooling performance evaluation.
14 Question 24, "Discuss the adequacy of quenching
15 tests designed to permit rod embrittlement for this reactor
16 in light of ORNL-TM-3188, Pages 15 to 16, and explain in
17 what manner embrittlement has been considered in the ECCS
18 analysis for this reactor."
19 As I indicated just previously, the quenching test
20 data that we have obtained and others have obtained determine
21 an area of safe operation shown in Figure 1 of our additional
22 testimony on July 13, 1971. Embrittlement was considered by
23 completing the requirements of the interim policy statement
24 from the AEC, and that the results presented in Tables 1 and 2
25 of this additional fall well within the area of safe operation

shown in Figure 1.

Question 25, "Explain how the effect of flow blockage has been considered calculating peak temperatures. Discuss experimental data relied upon for the calculations. See ORNL-TM-3188, Page 22."

Effective flow blockage has been considered on the peak temperature occurring during loss of coolant by determining the amount of assembly blockage that one could expect based on the multi-rod burst test program. This amount of assembly flow blockage is used to calculate the amount of flow redistribution around that assembly, and therefore determine the reduction in flow through the assembly available for heat transfer. With this flow through the assembly and the worst local channel blockage, this is determined based on the saem series of rod burst tests, and local flow redistribution calculation is performed to determine the amount of flow reduction to the highest worst local channel blockage. Then a calculation is performed on the heat transfer from the rods which exhibit the highest local channel blockage and which give the greatest rod to rod contact.

As I mentioned previously, in the area where the rods are in contact, no heat transfer is assumed. In a two-dimensional head conduction analysis as made to determine the possible temperature rise associated with the blockage. As I indicated previously, there was less than 100 degrees

Fahrenheit.

I should note here that it was in the analysis to determine this temperature increase of the fact that the blockage does in fact increase the heat transfer in the vicinity of the blocked rods. This is during heat transfer tests where various amounts of blockage were assimilated in a rod bundle and the actual heat transfer measured. This showed that the effective blockage was one of atomizing the large droplets of water which were entrained in the same period. This atomization actually gave us better effective heat transfer of that coolant. This improvement in heat transfer due to atomization was not accounted for conservatively in the calculation of the effects of flow blockage on possible increased temperature.

1 MR. MOORE: Question 26, "Discuss the criticism
2 of the PWR and/or BWR-FLECHT. Tests contained in ORNL-TM-
3 3188, pages 24 and 25 and what corrective steps if any
4 have been taken in the present analysis?"
5 The criticism of the PWR-FLECHT tests contained
6 in this report primarily concerned the fact that the
7 blockage, the simulation of flow blockage in the FLECHT
8 test was performed with orifice plates and the argument
9 was that these orifice plates did not correctly simulate
10 the kind of physical geometry you could expect under
11 blockage conditions which would be more of a tapered kind
12 of a blockage rather than a sharp-edged orifice.
13 However, the Idaho Nuclear Corporation performed
14 similar flow blockage tests where they used a tapered
15 plate in order to more correctly simulate the geometry
16 of the expected flow blockage. They reported these
17 test results and confirmed that the flow blockage using
18 the orifice plates was, the effects of this flow blockage
19 were similar to the effects they received with the tapered
20 plate. Therefore, the results that I just mentioned in
21 our FLECHT test which showed we in fact got improved heat
22 transfer performance were confirmed for geometries more
23 closely associated with those expected under actual flow
24 blockage.
25 Question 27, "How have the unanswered problems

1 contained in ORNL-TM-3188, page 30, been resolved in the
2 analysis for this plant?"
3 Again, these questions relate to the effects
4 of rod burst and flow blockage and also possible clad
5 embrittlement, and as I indicated previously, these
6 effects have been evaluated and experimentally determined
7 and they have been incorporated into either the analyses
8 of the loss of coolant accident and the performance of
9 the ECCS system or its setting appropriate limits for the
10 consequences of the loss of coolant accident.
11 Question 28, "In the Westinghouse ECC performance
12 of 6/1/71 explain in more detail the basis for altering
13 the assumptions which it is alleged were overly conservative.
14 What tests and experiments are the changes based upon
15 and what is the similitude of those tests to the LOCA."
16 There were several assumptions which were
17 modified as indicated in the reference to June 1, 1971
18 report. One of these assumptions was to assume a five
19 percent reduction in the peaking factor because of a
20 reduction in nuclear uncertainty. This reduction, the
21 basis for this reduction is described in WCAP-7308 and it
22 is based upon critical experiments, measurements made of
23 power distribution in critical experiments, as well as
24 in operating reactors.
25 And an evaluation of the performance there of

1 our movable detector system was performed and determined
2 that the accuracy was better than the originally assumed
3 ten percent, and in fact the data substantiated an accuracy
4 of better than five percent.
5 Therefore, we assumed a five percent reduction
6 in this total uncertainty factor.
7 Another change in the assumptions involved a
8 revised transaction boiling correlation. The transition
9 boiling correlation previously used in the design
10 calculation was overly conservative in the region of low
11 temperature difference between the wall and the heat sink.
12 This conservatism was determined by test, heat transfer
13 test, under conditions of flow quality and pressure which
14 relate to the conditions you would obtain in a loss of
15 coolant accident. We therefore modified the correlation
16 in this region, but at the same time the correlation was
17 made even more conservative where the temperature
18 difference is greater than 250 degrees Fahrenheit.
19 So the correlation was based on actual heat
20 transfer experiments that were performed.
21 With respect to heat transfer during the initial
22 stages of reflooding as determined by the flat heat transfer
23 test in previous calculations we considered the core
24 adiabatic, that is no heat transfer assumed, until the
25 entrained water reached the hot spot, and this occurs when

1 the cooling water floods to a level of about twenty
2 inches into the core.
3 The FLECHT results, however, showed that the
4 heat transfer exists immediately after the bottom of the
5 core is reached. So we took credit for this additional
6 heat transfer based directly on the FLECHT results,
7 using a conservative interpretation of these results.
8 Another change in assumptions for the analysis
9 was the treatment of the resistance of the upper core
10 support plate. In the initial calculations, design
11 calculations, the resistance and flow areas in the upper
12 core support plate were divided equally between the core
13 outlet plenum and the downcomer annulus. In reality the
14 resistance to flow into the downcomer annulus is much
15 higher and the flow area is smaller. So our initial
16 representation of dividing these resistances in areas
17 equally was in error and we revised this. This had the
18 effect of increasing the flow through the core, which comes
19 from the boiling of water in the upper plenum of the
20 vessel, in the vessel head.
21 I think that includes all the assumption which
22 were -- Excuse me. The assumption for decay heat
23 generation was previously described by Mr. Novak of the
24 AEC Staff, that we had an error in a couple of the sources
25 of energy for decayed heat, but these were corrected,

which had the effect of reducing the amount of decay heat generation. We are now using a decay heat generation rate consistent with ANS with twenty percent uncertainty. And these decay heat levels are based on large amount of experimental data, also.

Question 29, "What are the differences between the Staff calculations and assumptions and those contained on page 6 of the 6/1/71 report? Also the differences in the transition boiling correlation (page 24 of the same report), reflooding heat transfer (page 33) and discharge coefficient (page 35.)"

This question will be answered by the Staff and I have no further comment. I have discussed these in some detail in answer to the previous question.

Question 30, "How will the water level in the downcomer increase during the flow resistance time (see page 58 of the 6/1/71 report) if the flow resistance also in the loops carrying accumulation water to the downcomer? Discuss this in light of the discussion of the water plug preventing steam venting discussed on page 64 of the report."

I am not quite sure of the thrust of this question, but the water level in the downcomer will increase at a faster rate during the initial reflood transient when we assume the cold leg pipes are plugged with accumulated water.

1 Since this prevents steam venting through the unbroken
2 loops this retards the amount of water that goes into the
3 core itself and therefore the downcomer, the water is
4 added to the downcomer level. Once the cold leg lines
5 become unplugged, then the rate of increase of water in
6 the downcomer will be reduced.
7 Question 31, "Compare the quality of similitude
8 to a LOCA of the tests relied upon by Applicant with the
9 rod tests discussed in ORNL-4635. See page 3 and 75 of
10 that report."
11 In the tests discussed in the Oak Ridge report
12 in-pile effects were simulated in that a rod was actually
13 in a core, and actual nuclear energy was created in that
14 rod. The geometry, however, of the rod bundle situation
15 was not simulated adequately in the Oak Ridge tests.
16 In the tests relied upon by Westinghouse the
17 pitch, fuel rod, and thimble diameter were identical to
18 those in the standard fuel system. More rods per test
19 assembly were tested and a longer hot spot was employed
20 than in the Oak Ridge tests, which is more representative
21 of a reactor situation.
22 The results of both tests, however, with respect
23 to flow blockage were very similar.
24 Question 32, "Does the Applicant's analysis of
25 rod failure compute the failure at approximately

1 twenty-five to thirty seconds and if not why not? See
2 ORNL-4635, page 13."
3 The failure of rods is computed when the
4 differential pressure from the inside of the rod to
5 the primary system exceeds the stress capability of the
6 cladding. And the stress capability is a function of the
7 cladding temperature. Therefore, rod failures will occur
8 throughout the transient once the cladding temperatures
9 reach a threshhold of about 1200 to 1300 degrees
10 Fahrenheit. So that rod burst would be predicted on from
11 the time the hot spot reaches that temperature on through
12 the transient 'til the temperature transient for all the
13 rods is turned around with bottom flooding by the
14 accumulators.
15 So the specific time of twenty-five to thirty
16 seconds is not really appropriate.
17 Question 33, "Discuss the Applicant's assumption
18 that rod swelling and bursting is random in light of the
19 ORNL-4635 results. See pages 28, 32, 46, 47, 66-67, 68
20 and 75."
21 The original results were obtained for a very
22 short rod, I believe it was twenty-seven inches, with an
23 axial power distribution which was quite peaked toward
24 the center and it was peaked over a region of about
25 two inches. And the failures were observed to occur

1 essentially in that two-inch region of peak power, which
2 is what one would expect. It's interesting to note that
3 even with this kind of a localized location of failures
4 that the total blockage was still only about forty-eight
5 percent. The tests that we performed on the multi-rod
6 burst tests, we had three-foot rods, with a power
7 distribution more representative of the axial power
8 distribution you would expect in a reactor. And these
9 tests did in fact confirm that the rod burst under these
10 kinds of power distribution shapes were quite random.
11 And we took the resulting rod burst configurations and
12 from these determined then the expected amount of flow
13 blockage.
14 So you have to relate, be careful that you
15 properly simulate the entire distribution conditions in
16 determining the non-randomness of rod burst.
17 Question 34, "To what extent does the
18 Applicant's analysis consider propagation of the failures
19 caused by fragments from burst rods, fuel pellets, or
20 other causes? See ORNL-4635, pages 32 and 69."
21 Our analysis does not consider propagation
22 of the failures caused by fragments from burst rods or
23 other causes. These should have little additional
24 effect on the extent of fuel rod distortion, and this seems
25 to be borne out by the results obtained in the Oak Ridge

test itself. Under the loss of coolant, the assumed loss of coolant conditions for the design calculation, a very large fraction of the core is assumed to burst. And so any additional failures due to some propagation from fragments would not really be significant.

Question 35, "To what extent does the ECCS performance analysis consider bowing of the rods? See ORNL-4635, Page 33."

Effect of bowing of the rods per se is not considered in the ECCS performance analysis. However, some FLECHT experiments which were performed with bowed rods were evaluated and reported in a paper presented by J. O. Cermak in the June, 1970, ANS meeting which indicated that with bowed rods you could in fact improve the heat transfer coefficience. Possibly from the same kind of a phenomena I discussed earlier where you tend to break up the large droplets of water, of entrained water.

Question 36, "To what extent do the predicted levels of radioactivity and their composition in a LOCA in the analysis of this plant correspond with the results of the tests reported in ORNL-4635, Page 55, 61, 69-70 and 75. Also discuss the experimentally proven quantity of unreactive iodine and its effect on plateout and spray performance."

I'd like to defer the answer to this question to Mr. Wiesemann. This is not specifically in my area of expertise.

Question 37, "Discuss the reasonable projections for rod performance at the temperature levels expected for this reactor compared to the levels in the ORNL-4635 tests. See Page 65, 66."

The peak clad temperature for the Indian Point 2 reactor is expected to be less than 1500 degrees Fahrenheit, if a major loss of coolant accident were to occur. This is compared to the design calculation of 2300 degrees Fahrenheit. In this event with a 1500 degree Fahrenheit peak clad temperature less than 25 per cent of the fuel rods would be expected to experience distortion.

Question 38, "Explain why at least some of the channel blockage factors are not supplementary rather than a mutually exclusive and has this been considered in the Applicant's analysis. See WCAP-7015, Division 1, Page 3."

The effects of both inlet flow maldistribution and flow redistribution due to local power variations have been considered. They are considered simultaneously in the THINC code analysis

Question 39, "To what extent are the codes THINC I and II used in the analysis of this reactor and what assumptions have been verified by experimental results. Discuss the experiments and their similitude to a LOCA."

THINC I and II are computer codes which are used for steady state analysis and for the analysis of certain transients. These determine the thermalhydraulic conditions that exist within the reactor core. They are also used to describe the initial conditions for a loss of coolant accident. THINC I has been verified as a conservative code using in-plant

1 data obtained at operating reactors.

2 THINC II, which treats the details within a fuel
3 rod assembly, has been verified with out-of-pile rod bundle
4 heat transfer test data. Experiments in-pile were of course
5 exact similitude.

6 In the out-of-pile tests the geometry was also
7 simulated to represent a core. The range of hydraulic
8 conditions considered in these tests were up to eighty to
9 ninety per cent void fraction, which are representative of
10 what you'd obtain in a loss of coolant accident.

11 MR. TROSTEN: Mr. Chairman, Mr. Wiesemann is pre-
12 pared to respond to Question No. 36, which is the remaining
13 question asked by Mr. Roisman in this series.

14 CHAIRMAN JENSCH: Would you come forward, Mr.
15 Wiesemann, please.

16 MR. WIESEMANN: I'd like to repeat the question.

17 "To what extent do the predicted levels of radio-
18 activity and their composition in a loca in the analysis of
19 this plant correspond with the results of the tests reported
20 in ORNL-4635, pages 55, 61, 69 to 70 and 75? Also discuss
21 the experimentally proven quantity of unreactive iodine and
22 its effect on plateout and spray performance."

23 The results of ORNL 5635 show that the releases of
24 iodone, noble gases and other fission products were far below
25 the assumptions made for Indian Point #2 loss of coolant

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analysis.

The assumed iodine release was one hundred times higher than the releases indicated in ORNL 4635. The organic fraction of iodine was two hundred times higher than assumed in ORNL 4645. Noble gases were greater than a hundred times higher and other efficient products were greater than fifty times higher. All these ratios relate to the assumed quantities for Indian Point 2 being higher than those indicated by the test results reported in ORNL 4635, giving some indication of the order of magnitude of conservatism in those assumptions.

The part of the question asked about the effect of the unreactive quantity of iodine on the plateout and spray performance, to the extent that the iodine, organic or unreactive iodine fractions might be expected to be less than those assumed, it reduces to some extent the requirement for performance of the spray and also importance of plateout.

However, there is no direct effect on the performance of these systems. The capability to remove iodine for which they were intended is unaffected.

MR. TROSTEN: Mr. Chairman, witnesses Moore and Wiesemann remain available for further cross-examination at this time as Mr. Roisman chooses to conduct.

CHAIRMAN JENSCH: Well, before we proceed with that let us take the usual recess.

At this time let us recess to reconvene in this room at eleven o'clock.

(Brief recess.)

CHAIRMAN JENSCH: Please come to order. Does the Regulatory Staff desire to interrogate the witness Moore in any respect at this time?

MR. KARMAN: Mr. Chairman, we have no questions at this time. We would like to take a look at the transcript this evening and see if there is anything there.

CHAIRMAN JENSCH: Citizen's Committee desire to have any clarification questions before cross-examination?

MR. ROISMAN: Yes, Mr. Chairman, just a few if I may.

CHAIRMAN JENSCH: Mr. Moore, will you return to the stand. Mr. Wiesemann, will you come forward and be available.

Proceed, please.

MR. ROISMAN: Mr. Moore, directing your attention back to question 7, I believe you testified that the metal-water reaction is calculated continuously during the course of a loss of a coolant accident, and as I understand it a factor affecting metal-water reaction is the amount of steam or water available and the temperature and a variety of other factors like that. Do you use the assumption of uniform mixing when you make the calculations of what the metal-water reactions will be at any given spot in the core?

MR. MOORE: As I indicated, the calculation of

1 metal-water reaction directly uses a parabolic rate
2 equation, does not take into account whether or not there
3 is water or steam available. So it really doesn't make
4 any difference. We assume that there just is enough,
5 there always is enough water available to participate in
6 the reaction.
7 MR. ROISMAN: Is the reaction affected by
8 whether the water is more steamy or more non-steamy?
9 In other words, is the composition of the water a factor
10 in the quantity of metal-water reaction?
11 MR. MOORE: I believe it can be, but this would
12 only be in the direction of reducing the total reaction.
13 MR. ROISMAN: In other words, the kind of
14 assumption that you use in the parabolic rate law, take
15 the worst case as existing at all times, in other words,
16 the most amount of metal-water reaction that could occur,
17 is that correct?
18 MR. MOORE: That's correct.
19 MR. ROISMAN: Now can I direct your attention
20 to question 10. I'm a little unclear as to exactly how
21 you compute the metal-water reaction. I think you talked
22 about dividing the core into regions and so forth. Are
23 you able to say, could you tell me now, if we had a
24 diagram of the core here, which rod is going to have the
25 metal-water reaction and what percentage of metal-water

1 reaction will occur at that rod and what the temperature
2 levels are for the rods that immediately surround it? In
3 other words, are your calculations that precise?
4 MR. MOORE: The calculations are that precise
5 in that we take individual rods at specific power levels
6 in the core and calculate their metal-water reaction
7 to determine the kind of a distribution you are talking
8 about. Then I would take these rods at these given power
9 levels and then determine where they are in the core,
10 where in the core does that power level exist. Yes, that
11 can be done. That's what we start from basically, power
12 distribution in the core, and then break the core up
13 into various regions of power level. So that could be done.
14 It's not normally done as a presentation.
15 CHAIRMAN JENSCH: Excuse me. I wonder if we
16 could have some of those other questions that you did
17 propound answered, if we can.
18 Is your analysis limited to, do I understand it,
19 one rod, and do you know the temperature of the surrounding
20 rods?
21 MR. MOORE: Yes, we do.
22 CHAIRMAN JENSCH: What is the temperature of
23 the one rod?
24 MR. MOORE: It depends on the specific power of
25 that particular rod. The temperature of the hottest rod

in the core, the peak temperature, is 2300 degrees. As I indicated before, two percent of the core is above 1800 degrees and there are corresponding lower temperatures for other rods in the core.

CHAIRMAN JENSCH: Well, are those necessarily, those surrounding this peak rod, 2300 degrees? Do I make it clear? My question is what is the temperature of the rods nearest the 2300-degree rod?

MR. MOORE: I would have to confirm this later, but I would say the temperature of the rods surrounding the peak rod are probably 1800 to 2000 degrees.

CHAIRMAN JENSCH: You feel that those will be confirmed. If there is any difference in that will you so indicate for the record?

MR. MOORE: Yes.

CHAIRMAN JENSCH: Very well. Thank you. Would you proceed.

MR. ROISMAN: Yes.

Mr. Moore, following along this same line, the calculation of, let's take just for purposes of discussion, a single rod that is at 2300 degrees Fahrenheit, which I assume is an assumption that is in the Westinghouse ECCS analysis, and are you also able to say how much metal-water reaction that rod will have, how much heat will be generated by that metal-water reaction and how the surrounding

1 rods are affected by the specific metal-water reaction of
2 that specific rod?
3 MR. MOORE: Yes. We can calculate or determine
4 what the metal-water reaction is in that rod.
5 MR. ROISMAN: Do you calculate what its effect
6 will be on the temperature of the immediately adjacent
7 rods?
8 MR. MOORE: It has very little effect on temperature
9 of immediately adjacent rods.
10 MR. ROISMAN: Could you explain that further?
11 I mean my understanding is that the metal-water reaction
12 generates heat.
13 MR. MOORE: It generates heat within the specific
14 rod itself and then the question is how is that heat
15 transferred out of that rod into the coolant channels
16 between rods?
17 MR. ROISMAN: Right.
18 MR. MOORE: So it's mainly a concern about the
19 temperature of the rod itself where the energy is generated,
20 not the adjacent rods.
21 MR. ROISMAN: But as I understand it, I mean the
22 way the rods are constructed, their purpose in normal
23 operation, not in accident, is to be very good at transmitting
24 heat. That is they generate heat inside and the only way
25 the water gets heated up is by being transferred out of the

rod. Why isn't that very effective method of transferring heat a factor in transferring the heat of the metal-water reaction to an adjacent rod?

MR. MOORE: Because the heat is transferred directly to the coolant. The only effects you would get in transferring heat to the adjacent rod would be mainly through the temperature of the surrounding coolant, which is taken into account, or by radiation effects which are very small, because the temperature differences are small. So the surrounding rods, the adjacent rod sees the same coolant, the same channel, so the main effect of the adjacent rod would be heating up the coolant in the channel and give you a sink temperature to transfer heat from the other rod.

MR. ROISMAN: What about the swelling of the 2300-degree rod if the metal-water reaction heat were occurring below the point of swelling and if the swelling had blocked the channel? Would that change the effect on the adjacent rod?

MR. MOORE: Oh, yes. As I mentioned earlier in considering the effect of blockage and rod-to-rod contact, now you have the rods which are in contact which are essentially transferring heat together and we did the calculation on the basis of no heat release from those portions of the rods which were in contact.

So the temperature of the part of the rod which is in contact with another rod is calculated using the metal-water reaction associated with both rods, adding energy to the rods which now has to be transferred around the rest of the remaining peripheral of the rod which is at the coolant.

MR. ROISMAN: Let's see if I understand. You say the way you compute the heat of two rods where they have swollen together or one has swollen and is touching the other, is to assume that both rods are as hot as the hottest?

MR. MOORE: I don't recall the specific situation. I believe we take the -- I believe we did use the temperature of the hottest rod. I would have to check that.

CHAIRMAN JENSCH: I wonder if I could get that answer a little more clearly. You take the temperature of the hottest rod and assume that the adjacent rods which are affected by the swollen rod to be the same?

MR. MOORE: Where they are in contact.

CHAIRMAN JENSCH: Thank you.

MR. ROISMAN: By where? Do you mean at the physical point where they are in contact?

MR. MOORE: Only in the physical regions where they are in contact, that's right.

MR. ROISMAN: What are you assuming happens to

the heat of the touched rod as opposed to the touching rod? Let's assume the figures of 2300 degrees Fahrenheit temperature. What does it do to the heat of the remainder of the rod?

MR. MOORE: Well, the heat that's generated there in the area of contact has to be transferred around the rod, circumferentially, to the point where it can now be released to the coolant, which is flowing by the rod.

MR. ROISMAN: You are assuming that the heat will move horizontally?

MR. MOORE: It goes from the highest temperature to the lower temperature.

MR. ROISMAN: You don't mean horizontally and not vertically?

MR. MOORE: Circumferentially, there was no credit taken for any axial conduction along the length of the rod. This would further reduce the temperature, but now you must be careful about the length of the actual amount of touching you can get before you take credit for axial conduction. So this was ignored in the analysis.

MR. ROISMAN: You say that it would be conservative to assume that the heat, in effect, remained right at the little band where the contact between the rods occur. But in terms of computing the extent of metal-water reaction of the entire rod, why wouldn't it be more conservative to

1 assume that the whole rod gets heated or goes to a higher
2 heat, and since there is more water-metal reaction to
3 higher temperature, you get more percentage of the rods
4 zircalloy having a reaction?
5 MR. MOORE: That will have to be a very small
6 effect considering the geometry and the number of bursts
7 that you get based on the rod burst test. I don't see
8 that that contribution of heat or the amount that might
9 get transferred axially is really significant at all in
10 metal-water reaction.
11 CHAIRMAN JENSCH: Let me enter at the moment.
12 Maybe this isn't the time to do it. Would the parties feel
13 it would be helpful to have an easel here with a paper
14 so some sketching could be done? I think we get some
15 difficulty in following just how far the point of contact
16 is between the touching and the touched, whatever the
17 description be for these rods. I wonder, when you come
18 to more thorough cross-examination, if it would be helpful
19 for the parties to have some sort of an easel so the
20 witness can draw what he is describing.
21 MR. ROISMAN: It would be helpful for us,
22 Mr. Chairman, I think.
23 MR. TROSTEN: I agree with that.
24 CHAIRMAN JENSCH: Proceed, please.
25 MR. ROISMAN: Getting back, now, to this question.

MR. MOORE: Yes.

MR. ROISMAN: Do I understand your testimony to be that if the heat from the point of contact between rods was assumed to be axial rather than circumferential, that there might be some contribution to the amount of metal-water reaction, but in your opinion, it would be so small that it isn't important to take into account?

MR. MOORE: Yes. I feel that the amount that might be transferred just because of the geometry is very small, and therefore would be insignificant with respect to the metal-water reaction.

MR. ROISMAN: I am still trying to focus on this one point, 2300 degrees Fahrenheit rod and its effect on the other rods. I am unclear on it, if you will, the domino effect.

As the one rod swells and begins to touch one or more than one of its surrounding rods, things happen to those surrounding rods which can affect their ability to transfer heat or even their tendency to swell or not to swell. I am wondering, does your computation take account of the effect that are the middle 2300 degrees Fahrenheit rod swells and touches the adjacent rod, which in turn gets hotter and then may itself swell and touch an adjacent rod, and so forth? In other words, how do you take into account the continuing changes inside the core,

1 such as the swelling and touching of rods in the initial
2 metal-water reaction in making your final computation,
3 that is at the end, no rod will have gotten more than
4 2300 degrees Fahrenheit and no more than X amount of channel
5 blockage will occur?

6 MR. MOORE: Well, I think one thing we should
7 understand is that the rods will swell and burst at
8 temperatures well below the threshold for metal-water
9 reaction. The threshold for any kind of metal-water
10 reaction is considered in the order of 1800 to 1900 degrees
11 Fahrenheit. The cladding will burst at temperatures of
12 1200, 1300, 1400, maybe even 1600 degrees Fahrenheit,
13 depending on the internal pressure versus the external
14 pressure. But before we get into considerations of metal-
15 water reaction, all the rods which are going to burst
16 certainly around that rod have in fact burst already.

17 So there is really no domino effect here involved
18 in determining metal-water reaction. The domino theory
19 or interaction effects from rod to rod are important, and
20 that's the reason we did go to a multi-rod burst test
21 experimental setup where we heated a number of rods
22 together which did fail at different times as they approached
23 this 1200, 1300, 1400 degree Fahrenheit temperature. It
24 was this interaction that was observed from the tests that
25 was used to determine the amount of rod-to-rod contact in

1 the geometry that we could expect.

2 MR. ROISMAN: You mention that you did a multi-

3 rod test. Did those tests involve rods which had varying

4 pressures inside of them?

5 MR. MOORE: Yes.

6 MR. ROISMAN: Did the varying pressures attempt

7 to simulate what the varying pressures would be for a

8 grouping of rods, a typical grouping of rods in a reactor?

9 MR. MOORE: Yes.

10 MR. ROISMAN: How were you able to do that? What

11 did you do in order to compute that? What did you assume

12 about the rods to determine that one would have fifty and

13 another would have 250 in terms of pressure measurement?

14 MR. MOORE: Well, as part of the design of the

15 core, you calculate as a function of burn-up, what the

16 internal pressure is in a fuel rod. This internal

17 pressure varies with lifetime as the fission gas builds

18 up and the heat transfer characteristics change in the rod.

19 Sowe have a large amount of design calculations

20 which predict internal pressures versus lifetime.

21 MR. ROISMAN: But, as I understand it, the fuel

22 bundles contain rods of the same age?

23 MR. MOORE: Basically, yes.

24 MR. ROISMAN: Why wouldn't they have the same

25 pressures, then?

1 MR. MOORE: There are some slight differences
2 because there are differences in power level from rod to
3 rod within assembly. These are, of course, much smaller
4 than the differences you get with lifetime from one assembly
5 to the other. You are correct.
6 MR. ROISMAN: In your multi-rod tests, the
7 differences in pressure that you have assumed, are those
8 differences in pressure justifiable based solely upon
9 power differences that might exist between rods in a
10 typical bundle?
11 MR. MOORE: I believe so, in a bundle itself.
12 Of course, we had to look at pressures, bundle pressures,
13 which were typical of various burn-up bundles in a core.
14 So we looked at many different initial pressures to look
15 at different kinds of assemblies which could exist in a core.
16 MR. ROISMAN: We hear multi-rod tests and were
17 discussing the ones in WCAB-7379, Volume II, of the
18 proprietary documents.
19 MR. MOORE: May I see that, please?
20 MR. ROISMAN: Yes.
21 MR. MOORE: No. These are the single rod tests.
22 The ones I am referring to are the multi-rod tests.
23 MR. ROISMAN: Do you know the document number?
24 I don't have it here with me right now. I believe I could
25 get it. Do you want to take a minute?

MR. MOORE: Yes.

MR. ROISMAN: Why don't we. I wanted to look at it. I saw the report. I'm not sure that I had it here. I wanted to look at the chart on pressure differences and talk about that for a moment.

MR. MOORE: References WCAB-7495-L, Volume I and II.

MR. ROISMAN: Could you turn to the charts which show what the differences in temperatures were of the rods that were tested at one time?

MR. MOORE: It will be Table 19, location of peak temperatures corresponding to heat-up rates.

MR. ROISMAN: I'm not sure what you are looking at. I don't remember if I received that document under protective order or not.

MR. MOORE: I have the temperatures.

1 MR.ROISMAN: Does it show the pressures of the
2 individual rods?
3 CHAIRMAN JENSCH: Unless there is some restriction,
4 you should feel free to go up if you don't have a copy, and
5 look at what he has. Perhaps you can interrogate well enough
6 from there so the record will have that.
7 MR. ROISMAN: Is there a problem with that?
8 MR. TROSTEN: Mr. Jensch, I think we have to take a
9 look at what the document is that Mr. Moore is looking at and
10 determine first whether Mr. Roisman has been given that. I'm
11 not quite sure at this point whether he has been give it or
12 not.
13 MR. ROISMAN: I'm not either. I have another
14 technical person who has looked at documents. He would not
15 have looked at that because it is proprietary. I am just
16 not sure.
17 MR. JENSCH: I think you should be satisfied of
18 the proprietary character before there is general discussion
19 about it. I don't know whether this is a convenient time to
20 do it or go on to something else and at the noon hour resolve
21 that matter.
22 MR. ROISMAN: Why don't we do that. I will just
23 go back to those later.
24 Mr. Moore, you mentioned earlier that at the 2300
25 degree Fahrenheit temperature, that the rods, most of them,

would have already burst; that the bursting takes place at a substantially lower figure.

Am I correct that whether the rod burst or not is a function of its internal pressure, ductility of the rod cladding, the temperature and the speed at which it reaches that temperature, that all of those will affect whether it bursts or swells; is that correct?

MR. MOORE: Basically correct, right.

MR. ROISMAN: Swelling, because it can block the channel more fully, is a more serious condition than bursting; is that correct? That is in terms of effect on cooling?

MR. MOORE: In terms of blockage, yes.

MR. ROISMAN: How do you figure how many rods will have swollen as opposed to bursted? What goes into that computation?

MR. MOORE: Well, we don't specifically compute whether a rod bursts or swells with respect to the performance of the ECCS. We rely on the experimental data which derives this for us by running the various assemblies through different heating rates, internal pressures and maximum temperatures. From that, then determine what is the worst possible situation we can have in the core. We then arbitrarily assumed that that worst blockage and configuration was in fact the blockage we would get in the hot assembly with the hottest rod. This is probably not the case. But

in doing the analysis, we assumed that the worst blockage which might have been obtained from a low heating rate or a low internal pressure and had a lot of swelling involved with it, was assumed to be the kind of blockage we could get at the hot spot where we would have a high heating rate and possibly a higher differential pressure.

MR. ROISMAN: Do you assume that and rod has the flow blocked 360 degrees around it?

MR. MOORE: No. There was no case where we had full 360 degrees contact on any rod. It did not exist.

MR. ROISMAN: You mean no case in the experiments that were run?

MR. MOORE: That's right.

MR. ROISMAN: Do those experiments use irradiated fuel rods or non irradiated fuel rods?

MR. MOORE: The specific multi rods experiments used non irradiated rods. The characteristics of irradiated road were determined separately. It was determined that there was no difference between irradiated and unirradiated behavior. For that reason we went to the more easily used unirradiated tests.

MR. ROISMAN: When you say there is no difference, do you mean whether a rod is irradiated or not won't affect when it will swell rather than burst?

MR. MOORE: It has very little effect, that's right.

1 MR. ROISMAN: What about how it will swell? That is
2 as to whether it will swell evenly all the way around or bulge
3 out on one side?
4 MR. MOORE: It is my understanding that tests per-
5 formed on irradiated rods when compared to tests performed on
6 unirradiated rods, you couldn't tell the difference by looking
7 at the rods, whether they were irradiated or unirradiated.
8 MR. ROISMAN: The rods that were used, were they the
9 twelve-foot rods that are used in this plant?
10 MR. MOORE: They weren't twelve-foot rods. They
11 were sections of a regular fuel rod.
12 MR. ROISMAN: In terms of the spacing that was used,
13 were they spaced the same distance apart as they would be in
14 this reactor?
15 MR. MOORE: The irradiated tests that we performed
16 were done on single rods and compared to unirradiated single
17 rod tests.
18 MR. ROISMAN: And it is your judgment that there is
19 no difference that will occur if you used groups of irradiated
20 rods in comparing the results to groups of unirradiated rods?
21 MR. MOORE: There should be no difference because
22 there was no difference for the single rod test.
23 MR. ROISMAN: How many rods have been tested? How
24 many irradiated rods have been tested? Give us some rough
25 idea.

MR. MOORE: Gee, I don't have that figure at all in my head. I would have to look it up.

MR. ROISMAN: In thousands, hundreds?

MR. MOORE: No.

MR. ROISMAN: Tens?

MR. MOORE: It is not thousands. I would have to get the number for you.

MR. ROISMAN: Could you get it for me for the unirradiated rods also?

MR. MOORE: Sure.

MR. ROISMAN: And also the number that have been tested, using the multi rod analysis?

MR. MOORE: Yes. I can get that for you most readily for the Westinghouse tests. I wouldn't be in a position to--

MR. ROISMAN: I understand that. I was referring to the Westinghouse test.

CHAIRMAN JENSCH: I don't know if you quite finished your answer, Mr. Moore. You said you wouldn't be able to get it for what?

THE WITNESS: I said I don't think I could have a reliable number for all the other tests that have been performed of a similar type outside Westinghouse.

CHAIRMAN JENSCH: Thank you.

MR. ROISMAN: Mr. Moore, alluding to your answer to Question 12, you discussed the fact that the core is

divided into regions for the calculations that are made. What was the size of the regions? That is how many rods are in a region and in what percentage of the core is each region represented?

MR. MOORE: Well, you can vary these regions in a code. Typically, I believe, we use ten. We split the core up into ten typical regions of ten different power levels.

MR. ROISMAN: In ORNL-4635, the 0.2 per cent was determined to be the amount of metal-water reaction that had occurred in rods at the 1800 degree Fahrenheit level. You said that the report pointed out there could be an error of plus or minus fifty per cent. In short, it could have been 0.3 per cent or 0.1 per cent.

You also mentioned that two per cent of the cladding in the analysis that Westinghouse does is assumed to reach 1800 degrees Fahrenheit or more temperature.

What percentage of metal-water reaction do you predict will occur for that, for those rods at 1800 degrees Fahrenheit?

MR. MOORE: We would predict zero.

MR. ROISMAN: You would predict no metal-water reaction at 1800 degrees Fahrenheit?

MR. MOORE: Yes.

MR. ROISMAN: What about at 1900 degrees Fahrenheit?

MR. MOORE: Well, now it is a function of how long

1 you are at that temperature.

2 MR. ROISMAN: In terms of your analysis for this

3 plant, or can't you tell me offhand?

4 MR. MOORE: I don't have those figures with me right

5 now.

6 MR. ROISMAN: What I am interested in seeing is how

7 the metal-water reaction--I think you said the total for this

8 plant is assumed to be 0.07 per cent.

9 MR. MOORE: Less than that, yes.

10 MR. ROISMAN: I'd like to see how that whole thing

11 was added up, how much metal-water reaction you assumed. As

12 precise as you have it, we would appreciate it if you counted

13 rods at certain temperatures and predicted what the metal-

14 water reaction would be for those rods. That would be helpful.

15 Along the same line, in computing how much the metal-

16 water reaction would be, I think you testified that one per

17 cent, this limit that has been set in the interim criteria,

18 means one per cent of the total quantity of zircalloy that's

19 in the reactor, which means the inside of the fuel rod swells

20 the outside of the fuel rod surface as counted in figuring

21 out how much there is going to be.

22 Do your computations of the metal-water reaction

23 assume that some reaction can occur inside the rod? Have you

24 taken into account oxidization and metal-water reaction on

25 the inside of the rods?

MR. MOORE: No.

MR. ROISMAN: You stated that you expect most of the rods to burst. Can you explain to me why you don't assume that there will be any metal-water reaction inside the rod?

MR. MOORE: I think I explained earlier in testimony that the amount of exposed area that you could have by the rod burst is very, very small. If you consider that, we will add fractions of a per cent to the total.

MR. ROISMAN: You are talking about the edges of the metal?

MR. MOORE: Edges and exposed in the vicinity of the burst, right.

MR. ROISMAN: What I'm interested in, is are you assuming that no steam goes inside the rod?

MR. MOORE: That's right.

MR. ROISMAN: Can you explain to me on what basis you make that assumption?

MR. MOORE: Well, as long as the rods are still hot and there is a driving force to prevent steam that tries to get in contact with the rod, is actually driven away. Once the rod is cooled where steam could come in contact or water can come in contact inside of the rod, obviously we are down to a temperature where we no longer have a metal-water reaction.

end

1 MR. ROISMAN: Can you explain to me what is this
2 driving force you are talking about?
3 MR. MOORE: As steam would try to come into the
4 rod and move up -- As water or steam tries to move up
5 into the rod, this would be heated up and pressure would
6 increase and it would be expelled from the rod.
7 MR. ROISMAN: In other words, the inside of the
8 rod, after a burst, and for some period after the burst,
9 remains hotter than the outside?
10 MR. MOORE: Yes. It is certainly hotter than
11 the steam and the surrounding coolant.
12 MR. ROISMAN: How does that same phenomenon
13 heat a steam away from the rods on the outside, the
14 phenomenon that these hot places tend to push the steam
15 away, drive it away?
16 MR. MOORE: Well, as the steam-water mixture
17 during reflood floods the core, this water and steam
18 reaches the surface of the rod and a portion of the heat
19 is given up to the steam and water. The water is vaporized
20 and the steam temperature heats up as it goes up through
21 the core. There is an expansion of the steam and water
22 as it goes through the core, and the heat is added.
23 MR. ROISMAN: But my question is, why isn't
24 the steam just pushed away from the hotter spots for some
25 time even after reflooding begins, and just channeled to

1 the cooler areas the same way as the steam is kept from
2 coming inside the hot fuel rod?
3 MR. MOORE: Well, there is some redistribution
4 of steam-water from rod to rod during the reflooding.
5 That's what one observes in the FLECHT tests and that's
6 how we determine the heat transfer effectiveness of that
7 steam and water during reflood. These are certainly much
8 lower heat transfer effectivenesses than one gets during
9 normal operation. But it is, nonetheless, effective.
10 MR. ROISMAN: As I understood your testimony
11 when we were talking about the burst rod, you said, as
12 a practical matter, no steam or water is actually going
13 to get inside the rod. It will come to where the little
14 hole is, and in your words, it will be driven out. What
15 I am wondering is the force that can drive the steam out,
16 keep it from getting inside the fuel rod. Why doesn't that
17 same force drive the steam away from the hottest parts of
18 the core when the steam begins to come up the channel
19 at the very hottest? Why isn't that steam pushed aside
20 and sent out other channels and it never reaches the hot
21 portion?
22 MR. MOORE: Well, the significant difference
23 with respect to getting steam inside the rods through a
24 burst hole is that the rod is an enclosed volume. As I
25 try to add steam into the rod, there is only a certain

volume in the rod. The pressure will build up and tend to prevent more steam from coming in. The situation with the core is an open lattice where it is not an enclosed volume. So I don't have the same kinds of forces generated in a pressure build-up at all, or very little with respect to the core itself, but within the volume of the rod, yes. By pressure, it prevents steam from coming in.

MR. ROISMAN: What about pressure in the channels as a result of blockage at some point above the place? Say we have a rod that has burst and the steam is starting to move up the channel. Above that burst rod an adjacent rod has swollen. Won't that give you at least some of the effects of this counter pressure that will tend to keep the steam out of that channel?

MR. MOORE: That is correct. There is some bypass of flow because we have a restricted area now for the passage of the steam-water coming up through the bundle. It is then bypassed by the flow that is taken into account in determining the effective heat transfer where we have blockages, ignoring the effect of atomization on the entrained water. Yes, there is a small effect there. It is taken into account in the analysis.

MR. ROISMAN: Do you always assume that a rod which has blockage in one channel has an open channel

1 someplace through which a coolant will be in contact with it?

2 MR. MOORE: No. We simulated the kinds of

3 assembly blockages that we observed in our multi-rod test.

4 The maximum blockage was about fifty percent. So there

5 was area. There were no cases where we had a 100 percent

6 blockage situation.

7 MR. ROISMAN: I was going to ask you to explain

8 what you mean when you say that you have a fifty percent

9 blockage. You mean that each channel was assumed to have

10 fifty percent of the flow with the channel blocked, or

11 that fifty percent of all the rods were assumed to have

12 all of their channels blocked?

13 MR. MOORE: Or neither of the above?

14 MR. ROISMAN: Or neither of the above, yes, or

15 both of the above.

16 MR. MOORE: The fifty percent blockage definition

17 is the amount of flow area existing with blockage minus

18 the original flow area over the original flow area. So

19 it is a measure of the area reduction for flow. Then

20 this area reduction is used to calculate how much flow in

21 fact would bypass that particular region of the core. It

22 is strictly a geometrical number.

23 MR. ROISMAN: Would it help to do it on the chart?

24 We now have one here. I am having a hard time understanding.

25 Show me six rods, one in the middle and five around the

1 sides, diagramming what fifty percent blockage means,
2 if you would.
3 MR. MOORE: If I look at an assemblage of rods
4 like this and then I would compute the flow area within
5 that assemblage of rods, which would consist of the area --
6 This is out of scale, obviously. But the area available
7 for passage of coolant around the rods. Then I look
8 at the case where I have a blockage and these rods will
9 swell and tend to close up the channels. Then when you
10 look down in this configuration and calculate now the area
11 I have for flow, it is fifty percent less in that boundary
12 because of the swelling of the rods, the blockage.
13 MR. ROISMAN: If I understand the diagram, it
14 has nine rods in it as you put it up on the rod. When
15 you assume fifty percent flow pockets, you are assuming
16 that fifty percent of the total area available for a
17 group of rods is eliminated, rather than saying that any
18 one rod is totally blocked as to all channels?
19 MR. MOORE: That's right.
20 MR. ROISMAN: Is that based upon a simplifying
21 assumption that you have used in order to be able to
22 compute flow blockage, or is it based upon experimental
23 results that show that the proper way to compute this is
24 to assume that there will be a reduction in areas of many
25 rods rather than all of the blockage occurring through,

1 just say, two of your nine rods and blocking off all of
2 their flow?
3 MR. MOORE: We do two analyses. We take the
4 analysis of an assemblage of rods like this and calculate
5 the amount of flow with blockage now that comes in here
6 compared to what would have come in if we didn't have
7 blockage. Remember, we have a neighboring assembly over
8 here now. There is a proportioning of flow between
9 the assemblies. If this assembly is blocked, then the
10 flow will tend to go out around that assembly, depending
11 on the amount of blockage we have in the assembly. So we
12 do one analysis to compute how much flow redistributes
13 from this assembly just due to the blockage. That's an
14 assembly flow.
15 Then we look at what happens to the hot rods in
16 this assembly which can have its flow channel blocked possibly
17 to a greater extent. In fact, it is to a greater extent
18 than the average of all these rods. Then you calculate
19 for an assembly of hot rods with that particular blockage,
20 how much flow redistribution is there now between that
21 hot rod and the remaining rods in the assembly. So I have
22 a reduction in flow due to the assembly blockage and then
23 a reduction in flow due to the local blockage.
24 That gives me now the flow that I will expect
25 around the hot rod. That, obviously, has been reduced

1 from the clean geometry case where I didn't have any
2 blockage.
3 That's just one part of it. That's how we
4 consider the blockage both on an assembly basis and on
5 a local basis. So one calculation is finer than the other,
6 a more fine structure.
7 MR. ROISMAN: Is the nine-rod assembly what you
8 actually use when you are figuring?
9 MR. MOORE: For the assembly blockage we used --
10 The results we obtained for a four-by-four, which is
11 sixteen rods. That is representative of a total assembly.
12 MR. ROISMAN: Do you assume that fifty percent
13 blockage is a physical -- That is fifty percent of the
14 channel is physically obstructed?
15 MR. MOORE: Yes.
16 MR. ROISMAN: Do you assume that that limits
17 the flow by fifty percent, or does it limit the flow by more
18 than fifty percent, or less?
19 MR. MOORE: Looking at the assembly, that
20 reduced the flow through that assembly by twenty-five
21 percent, compared to what the flow would have been in that
22 assembly had it been unblocked.
23 MR. ROISMAN: In making that calculation, how
24 would that be affected if this assembly were larger, if
25 it were a ten-by-ten?

1 MR. MOORE: Well, we took the blockage we got
2 from the test for a four-by-four and assume that occurred
3 over a full assembly.
4 MR. ROISMAN: Is it affected at all by the
5 assumptions you make about the adjacent assemblies?
6 For instance, did you assume they were hotter or cooler,
7 and how would that affect it? Let me give you an example.
8 Assume that the hot assembly is what you have assumed for
9 making your computation, and that each of the six assemblies
10 around it are 600 degrees Fahrenheit. How would that
11 affect the flow through the hot assembly?
12 MR. MOORE: The flow through the hot assembly is
13 a function of what is going on in adjacent assemblies.
14 What we did is take the hot assembly, and what the adjacent
15 assembly should be if this were the hot assembly. So
16 we have taken the actual power distribution we expect
17 from assembly to assembly in order to get this variation
18 in flow. So the adjacent assemblies are representative
19 of the typical adjacent assemblies to a hot assembly.
20 MR. ROISMAN: Did those remain constant during
21 the lifetime of the reactor? In other words, will you
22 always have the same neighbors, so to speak, around this
23 hotter assembly, which is one of a higher power density?
24 MR. MOORE: Pretty much. There is not too
25 much difference across two assemblies in terms of power

1 distribution with lifetime. You can set a typical number
2 which holds throughout life, yes.
3 MR. ROISMAN: Do I understand they are the same,
4 and they don't differ enough for you to be concerned with?
5 MR. MOORE: Not to be concerned with.
6 MR. ROISMAN: And you do not take into account
7 that difference?
8 MR. MOORE: We try to, or in effect, do search
9 for the difference, which is limited.
10 MR. ROISMAN: You do search for what you believe
11 will be the worst conceivable difference that could exist?
12 MR. MOORE: That's right.
13 CHAIRMAN JENSCH: Are you going to leave this
14 subject for a moment? I mean this configuration that he has.
15 MR. ROISMAN: Yes, I am.
16 CHAIRMAN JENSCH: I wonder if you could do
17 something closer to scale with those nine. What I have in
18 mind are your previous statements that a hot rod, assuming
19 it to be 2300 degrees, will affect the adjacent rods. Maybe
20 if there was some bursting of the hot rod, it will be in
21 contact with some adjacent rods. Can you put that in better
22 scale so we see how that situation might develop? If you
23 want to take another sheet and turn that over, you may.
24 MR. MOORE: I believe somewhere on the record --
25 I'm not quite sure where, -- there are some typical pictures

1 of burst rods and a cross-sectional view. I will sketch
2 a typical one. For example, there was one experiment where
3 we had a rod that was kind of formed like that, and next
4 to it a rod that swelled like so. This rod could have
5 had perhaps another burst rod touching it here. This rod
6 didn't touch. This rod didn't touch. You get a geometry
7 like that.
8 CHAIRMAN JENSCH: That would be a part of this
9 four-by-four analysis that you made?
10 MR. MOORE: Yes, looking into the four-by-four.
11 CHAIRMAN JENSCH: Would you have several clusters
12 of that type of anarrangement within the four-by-four?
13 MR. MOORE: Yes, at different levels. You have
14 different arrangements of this.
15 CHAIRMAN JENSCH: You mean different levels along
16 the twelve-foot rod?
17 MR. MOORE: Yes.
18 CHAIRMAN JENSCH: And some parts would be in
19 touch at one location at a rod and at a higher level it
20 would be in contact at a different location; is that correct?
21 MR. MOORE: That's possible, yes.
22 CHAIRMAN JENSCH: What did you find?
23 MR. MOORE: That it was the case.
24 CHAIRMAN JENSCH: It was the case?
25 MR. MOORE: Yes.

CHAIRMAN JENSCH: Can you give us some idea of what the cluster would be like looking down at one level on this four-by-four using that cluster you started with there?

MR. MOORE: Another four inches from this one, for example -- I'm not a very good artist here. These two rods, looking up another four inches of the channel, looked almost symmetric and undeformed. You see, you tended to form the rods in one location and burst them in one location. So that particular rod or this particular rod having burst down here, for example, is fairly uniform all the way up from there on.

CHAIRMAN JENSCH: Stay at the same level of that upper cluster you have. How would it be for a four-by-four arrangement? Would you have more clusters like that at the same level within the four-by-four?

MR. MOORE: You could have. The particular one I just happened to pick out at random. The rest of the rods looked pretty uniform. There was one up here in the corner that had a little bit of a contact there. So looking at this one at random, there happened to be two sets that had some kind of contact, this one and this one, and no others.

Looking at another one four inches up, there are two more sets, different sets that touch at a location.

1 CHAIRMAN JENSCH: Somewhat similar to what you
2 have depicted on that sketch?
3 MR. MOORE: Yes.
4 CHAIRMAN JENSCH: Thank you very much. Will
5 you proceed, please.
6 MR. ROISMAN: Mr. Moore, we will come back to
7 this in a second. I'd like to go back to the metal-water
8 reaction. I guess I am still a little unclear about this.
9 ORNL-4635 had predicted 0.2 percent of metal-water
10 reaction for rods at 1800 degrees Fahrenheit.
11 You said that you predict for this plant no
12 metal-water reaction at 1800 degrees Fahrenheit.
13 MR. MOORE: I don't think the Oak Ridge report
14 predicted that. They assumed they measured it.
15 MR. ROISMAN: Can you tell me, is your basis
16 for not predicting 0.2 percent metal-water reaction at
17 1800 degrees Fahrenheit based upon some experiments which
18 Westinghouse has run or with which you are familiar, that
19 demonstrate that there won't be any metal-water reaction
20 at that temperature?
21 MR. MOORE: These are based on experiments that
22 have been performed by others. I'm not aware of any
23 specific Westinghouse experiments in this area. But these
24 are the experiments which were added to and summarized
25 in the reference by Baker and Just that I believe you have

1 from Oregon. That's the basis for the parabolic rate
2 assumption.
3 MR. ROISMAN: Can you explain in a little more
4 detail that the most recent Oak Ridge National Laboratory
5 report doesn't require modification of that?
6 MR. MOORE: I'm not an expert on Zirc-water
7 reaction per se. But just looking at the report, it seemed
8 to me, number one, this is one data point only. Also,
9 it looked like it was pretty susceptible to interpretation
10 and measurement in the way they derived the amount of
11 hydrogen, and related this back to Zirc-water reaction.
12 So I think I really don't know the validity
13 of that or any conclusions with respect to Zirc-water. It
14 was not an experiment, as I understood, to specifically
15 work on Zirc-water reaction aspects.
16 MR. ROISMAN: Mr. Wiesemann, is this your area,
17 the water reaction? Mr. Moore testified that he is not
18 really expert in that. Are you?
19 MR. WIESEMANN: No. However, I am knowledgeable
20 in general. I don't think my expertise in Zirc-water
21 reaction area is any greater than Mr. Moore's. With regard
22 to the question he just answered, about tests performed
23 by Westinghouse, I am personally aware of some exploratory
24 type tests which were done a long time ago when we first
25 went into the use of Zircalloy cladding in reactors,

exploring just exactly the thing you were discussing. That is the temperature range of 1800 to 2000 degrees, and the effect of this type of condition on Zircalloy rods to confirm for ourselves that there was no significant metal-water reaction in that range of temperatures in order to confirm for ourselves. The results of this, as far as I know, were never published. In order to get further details on that, we would probably have to consult some of the people who actually performed those tests. I observed those tests but I was not actually performing the test myself.

MR. ROISMAN: I wonder if it would be possible to get whoever it is, the expert of the Applicant, on metal-water reaction here so that we could get some of these answers to questions. Ideally tomorrow.

MR. TROSTEN: Well, we will have to consult with the Westinghouse representatives and it may be that I want, during a recess, Mr. Chairman, to get a somewhat better feel from Mr. Roisman as to the exact nature of the questions that he wishes to ask so that we can determine precisely who the witness would be.

CHAIRMAN JENSCH: Very well. If you will do that during the noon hour we will have a further discussion about that.

MR. ROISMAN: Yes, Mr. Chairman.

Mr. Moore, let me direct your attention to Question 16, and this one also deals with metal-water reactions generally. Are you not the most qualified expert that's available from the Applicant to answer those or should I wait on that question?

MR. MOORE: I hate to be modest, but you probably ought to wait.

CHAIRMAN JENSCH: Is there anything that you can add to what you gave in your answer as I understand it? I take it you don't want his answer stricken for lack of qualification, and maybe he can support what evidence he did give us.

1 Can you propound questions related to that and see
2 how his qualifications come up?
3 MR. ROISMAN: I was going to ask, you discussed the
4 existence of some tests that had been conducted when you
5 investigated the problem discussed here in terms of uranium
6 dioxide and water and the eutectic formed by iconel and
7 zircalloy and the reaction, but you didn't tell me anything
8 about the tests. Perhaps you could describe those tests a
9 little bit and describe how they operated, so forth.
10 MR. MOORE: Well, we had the iconel grid in a
11 reactor contacting a zircalloy rod as it does in a reactor at
12 a local point with a spring, and then we heated up the total
13 assemblage of the rod and the brid and to the point of tempera-
14 tures, I forget the exact numbers, but they were up well into
15 the zirc water reaction temperatures approaching 2300 degrees,
16 and then observed what happened at the local contact point
17 between the iconel and the zirc rod, and as I indicated and
18 as other people have observed there is a eutectic formed
19 between the zircalloy and the nickel of the iconel grid, which
20 has a melting point of about 1760 degrees and we did get in
21 the test very local melting at this contact point. But this
22 did not create any difficulty in that the heat was carried away
23 from that local point sufficiently so that there was no block-
24 age, any additional blockage, or effects on the zircalloy rod
25 itself. So that this is based on holding this rod in the

1 iconel grid at about 2300 degrees for several minutes, which
2 is well beyond what you would expect in a loss of coolant
3 situation.
4 MR. ROISMAN: Let me see if I understand this. The
5 eutectic is formed at about 1760 degrees, is that right?
6 MR. MOORE: It melts at 1760.
7 MR. ROISMAN: You are saying that no reaction
8 occurs with the water until it reaches almost 2300 degrees
9 Fahrenheit?
10 MR. MOORE: No.
11 MR. ROISMAN: Exactly how does the melting occur?
12 Are droplets formed that would tend to drop down between the
13 rods?
14 MR. MOORE: Yes. There was very local melting, but
15 we didn't observe any droplets or any sputtering which you
16 might postulate under those conditions. It was a very
17 localized effect and that is what gave us the assurance that
18 this was not a problem for us.
19 MR. ROISMAN: Was the rod an irradiated rod that
20 was used?
21 MR. MOORE: I don't believe so.
22 MR. ROISMAN: Did it have fuel in it?
23 MR. MOORE: No.
24 MR. ROISMAN: Did it have pressure comparable to
25 the pressure that it would have in a reactor?

1 MR. MOORE: No.

2 MR. ROISMAN: Was there a steam-water mixture run
3 by it at comparable pressures under temperatures to what you
4 would expect in a loss of coolant accident?

5 MR. MOORE: In the specific test that I just men-
6 tioned I believe not. The FLECHT test also incorporated these
7 assemblies and there we had steam flow and atypical of a loss
8 of coolant situation. And we also did not observe any effect
9 of blockage or any gross melting that would give us any con-
10 cern.

11 MR. ROISMAN: Was there a tendency for the rods to
12 swell at the point where the spacers existed?

13 MR. MOORE: No.

14 MR. ROISMAN: Did the rod get perforated at the point
15 where the spacer existed or have a tendency to get perforated
16 there more than it might elsewhere?

17 MR. MOORE: No. There was no preferential perfora-
18 tion there either.

19 MR. ROISMAN: I think that, and perhaps I didn't
20 understand what you were saying about the FLECHT test, but you
21 indicated that in the test run with regard to the iconel that
22 the rod itself didn't have any pressure in it. How would you
23 test swelling or bursting if the rod was not pressurized?

24 MR. MOORE: In the FLECHT test the rods were not
25 pressurized. We had the multi-rod burst test where the rods

1 were pressurized. These are several sets of tests we are
2 talking about.
3 MR. ROISMAN: Did the multi-rod burst test have the
4 iconel spacer in there to test out the eutectic formation and
5 the interaction of that in the swelling of the rods?
6 MR. MOORE: No, it did not.
7 MR. ROISMAN: Do I understand that in computing the
8 total heat that would be generated either by a specific rod
9 or in a certain area of the core in the loss of coolant
10 accident that no account is taken of the reaction between the
11 eutectic and the water, the eutectic we have been discussing,
12 iconel, and zircalloy?
13 MR. MOORE: No. There is no heat addition assumed
14 by that eutectic.
15 MR. ROISMAN: On Question 17 you testified that the
16 presence of spacers does not cause the swelling or bursting or
17 so forth to be concentrated where the spacers exist on the
18 rods. First of all, can you tell me how many spacers are there
19 running up the length of the rods in this reactor?
20 MR. MOORE: In Indian Point there are a total of nine
21 spacers.
22 MR. ROISMAN: Are they equally spaced going up the
23 rod?
24 MR. MOORE: No, they are not.
25 MR. ROISMAN: Perhaps it's in the FSAR and I can

just look at it. Does it show where those spaces are?

MR. MOORE: Yes.

MR. ROISMAN: In the FSAR.

Now can you explain to me how it happened that the point at which the spacer was in contact with the rod--I think you said the heat tends to go away from there I believe you said faster than it will go away from other points along the road and therefore you would not expect swelling to occur. Would you explain that a little bit, and were there some tests that verified that?

1 MR. MOORE: I didn't mean to imply anything
2 with respect to rate, just the fact that the eutectic
3 formation is a very localized effect, just at the point
4 of contact, and that the heat transfer that occurred
5 from that point of contact was sufficient to limit the
6 effect so that it did not propagate or spread.
7 MR. ROISMAN: Is the point of contact a single
8 point on the circumference of the rod?
9 MR. MOORE: Yes.
10 MR. ROISMAN: Can you give me an idea of the
11 magnitude compared to the total circumference at which
12 there is contact between a spacer and rod?
13 MR. MOORE: We are talking about mils of contact,
14 a mil or a couple of mils, I don't recall the exact number,
15 with the rod itself.
16 MR. ROISMAN: This spacer, it does not completely
17 surround the rod. There isn't band or something like
18 that that goes around the rod?
19 MR. MOORE: No, it does not. It's a point
20 contact. These are spring type grids.
21 MR. ROISMAN: How are the springs attached?
22 What are the springs attached to at their other end. One
23 end is attached to the rod. Is the other end attached
24 to the other rod?
25 MR. MOORE: No, the grid.

1 Looking at a grid, it's a spacer like this with
2 the rods going through it, and looking in cross-section
3 within this box around the rod, around the assembly, there
4 are grids that contact the rod like so locally. It's
5 a very local point. The grid supports the rod.
6 MR. ROISMAN: Could you put in a couple of
7 adjacent rods on that lower drawing just so I could see.
8 These fingers or springs, are they attached to a structure
9 which is supported by the rod drive guide tubes which
10 go down through the assembly?
11 Now did the horizontal pieces to which the ends
12 of the springs are attached, did they touch the rods as
13 they run through?
14 MR. MOORE: No, no. They are supported, with
15 this whole structure which has springs which can contact
16 the fuel rods are supported on the control rod guide tubes,
17 which looking down an assembly there are twenty of these
18 distributed within the fuel assembly, and this grid
19 structure is supported to these which are not fuel rods.
20 MR. ROISMAN: I understand that, okay.
21 On that diagram it appears that each rod is
22 touched twice at each point. Is that the number of points
23 that it's touched by the spacers?
24 MR. MOORE: I'd have to check the number of
25 contact points I get in this particular grid for Indian Point.

1 MR. TROSTEN: If it seems appropriate or necessary,
2 Mr. Chairman, we might have a model that we could bring
3 in that would show this, if somebody wants that done.
4 CHAIRMAN JENSCH: I thought Mr. Moore was doing
5 a fine job with his sketching there and that may be adequate
6 until there is some more specific request.
7 Apparently since you are going to turn to another
8 matter would you turn back to the sketch on the previous
9 page, Mr. Moore, and tell us what is the distortion, if any,
10 of the most distorted rod shown in one of those clusters?
11 Is there some distortion around the entire rod at the level
12 such as depicted by that cluster? Is my question clear?
13 What I am trying to find out is it's something like the
14 pictures you see with the snake following the frog, the
15 whole thing stretched out. It's a rod stretched out all
16 around it when it is in contact at one place in the cluster.
17 MR. MOORE: Well, some of these rods can expand
18 fairly uniformly, if that is the question, so that around
19 the total circumference there is an almost uniform expansion
20 or bulge. This was one of the reasons we went into the
21 multi-rod testing, is that we observed with single rod
22 tests that the expansion of a rod could be such that it
23 would interact with other rods and once you realized that
24 then it was important to properly and experimentally
25 determine what this interaction could be. Thus the reason

1 for this series of tests.

2 CHAIRMAN JENSCH: I don't think I quite

3 understood your answer. Let me try another question.

4 When there is a point of contact at the level

5 for the clusters which you have depicted, I think your

6 answer was something that could happen. Did you find

7 in your experiments that it did happen, that there was

8 some distortion around the entire rod at that circumference

9 where there was a cluster?

10 MR. MOORE: We never got a distortion of a rod

11 around the rod which was sufficient to cause these rods

12 to be contacted around the total circumference. That

13 was not the case.

14 CHAIRMAN JENSCH: That was not quite my question.

15 As I understand it there are more or less single points

16 of contact at certain levels in your rods, is that correct,

17 as depicted by your sketch?

18 MR. MOORE: Under failure mechanism.

19 CHAIRMAN JENSCH: Yes. Now are the other portions

20 of the rod at that level distorted somewhat, even though

21 they weren't in contact with a further out rod? Is that

22 correct?

23 MR. MOORE: Yes.

24 CHAIRMAN JENSCH: They were. Thank you. Thank

25 you, Mr. Moore.

1 Do you have some additional questions before
2 the noon hour?
3 MR. ROISMAN: Yes, I do, Mr. Chairman.
4 CHAIRMAN JENSCH: Proceed. You may have a seat,
5 Mr. Moore. Thank you.
6 MR. ROISMAN: Mr. Moore, I guess my problem in
7 understanding this is trying to square your testimony with
8 the results of the ORNL-4635 analysis.
9 As you know, in the Conclusions section on page
10 seventy-five of that report they do indicate that in their
11 tests they found ruptures in swollen areas close together
12 within a two-inch axial distance. And in the other
13 analyses conducted, in the Oregon National Lab report
14 6548 and also in the IN-1453 some suggestion exists that
15 the point where the spacers contact the rods tends to
16 be a place at which more swelling is likely to occur. And
17 I am trying to understand what it is you base your
18 conclusion on that this won't tend to localize the swelling
19 of the existence of the place where the space exists.
20 Now you said the amount of metal-water reaction
21 there won't be very great. But will there be a tendency
22 for the swelling of the rod or the bursting of it to
23 occur at the contact points of the spacers or near there
24 rather than elsewhere in the rod?
25 MR. MOORE: No. The primary determinant of

where bursts are apt to occur is basically the peak temperature or the temperatures you reach along the rod, and I think the difficulty with the Oak Ridge tests is that while it had the in-pile effects simulated, it did not have the proper geometry conditions comparable to the Indian Point reactor.

Basically the heat generation tended to be maximized at the center of that twenty-seven inch long rod and it was quite peaked in the sense that there was a definite high-heat generation over that same two inches for which they got the burst.

So that if your hottest part of your fuel is localized to a very small area, then one expects the hot parts of the fuel to burst, and you get this non-randomness situation.

But in a reactor there are not such two inch type peaks that occur in the core. So that you have the fuel so to speak has the option to fail at different levels because they are at similar temperatures.

And that is what we observed in our rod burst tests where we had a more uniform typical of the axial distribution in the reactor and we got random, very random burst conditions.

And there is nothing at the grids themselves which tends to promote any kind of a flux peaking.

MR. ROISMAN: Now what about thie localized metal-water reaction? How much will the temperature increase as a result of that?

MR. MOORE: Talking about the eutectic?

MR. ROISMAN: Yes.

MR. MOORE: You will recall the eutectic situation is up around 17 to 1800 degrees Fahrenheit, and the rod will have burst before it got to that point elsewhere.

MR. ROISMAN: Every rod will burst before it gets to 17, 1800 degrees?

MR. MOORE: Pretty sure, yes.

MR. ROISMAN: Can you describe to me the power distribution the differences of this reactor compared to the Oak Ridge National Lab? In other words, I guess do you know it in terms of percentages? I'm just trying to get some idea. There are different places on the rods for this reactor where the rod has got its hottest spot? In other words, does the same rod have two or three places where it has a peak power?

MR. MOORE: No. We are primarily talking here now about an axial effect, since we are looking at non-randomness of failures in the axial direction. In other words, can we get at the same axial location in the core?

Looking at the axial power distributions they tend to be fairly uniform. They start out basically almost as a cosine, shape, tend to be peaked toward the center. As a

burner in the core takes places they tend to shift. The peak can shift up or down in the core but it's still not a sharp peak in that it exists for we will say one to three feet at least kind of thing, where a similar power distribution along the length of the rod is, and that is opposed to the Oak Ridge test where you are within a few inches.

MR. ROISMAN: Would you then say that the swelling and bursting can be expected to occur within a two-foot region of the twelve-foot rod?

MR. MOORE: Well, just looking at power distribution effects alone at any given time the failures would be expected to be toward the top of the core, if that is where the peak was, or toward the bottom of the core if that is where the peak was. But there are other parameters obviously that you have to bring into play, and that is the properties of the material itself and what differences there might be there. There may be differences in internal pressures, certainly, from assembly to assembly.

As we said earlier, the differences within an assembly are small, but internal pressures from assembly to assembly can be quite large, which says then that the burst characteristics, the swelling, the time at which they burst are going to be different, because we have a different driving force.

So there are many variables that come into play to

1 determine when and how a rod bursts. And it was these com-
2 binations of variables that were examined in the tests to be
3 sure that we could bound the configuration.
4 MR. ROISMAN: Yes. But my concern at this point is
5 with where, not when and how.
6 MR. MOORE: I am even saying where. For example,
7 if the axial power distribution is very similar from assembly
8 to assembly as it tends to be certainly in the inner regions
9 of the core, if I just looked at that I would expect that the
10 burst would be tend to be located in the regions of highest
11 power, along the length of the rod, all other things being
12 constant or similar.
13 But if I have an assembly, one which has an internal
14 pressure of a few hundred pounds and one which has an internal
15 pressure of a thousand pounds or fifteen hundred pounds and
16 I heat both of these up, one will burst before the other.
17 MR. ROISMAN: But at what location along the rod?
18 Roughly the same two-foot space?
19 MR. MOORE: Not necessarily. Because now I'm looking
20 at the burst, at physically what is the condition of the
21 cladding, what kind of stress capability, strength do I have,
22 along the length of the rod?
23 MR. ROISMAN: You mean defects inthe--
24 MR. MOORE: Not defects, just variances in the
25 properties or some variances in the properties which tend to

1 randomize the burst.

2 MR. ROISMAN: In making the Westinghouse computa-
3 tions or computations on rod performances in terms of bursting
4 and swelling, do you assume that all of the bursting and
5 swelling occurs within the two-foot section which is where
6 highest power density is?

7 MR. MOORE: In doing the analyses I mentioned
8 earlier we assume that the blockage all occurred at one level
9 in that assembly. The whole assembly was all burst at one
10 level.

11 MR. ROISMAN: You said in the analyses that you
12 discussed before. Which one do you mean?

13 MR. MOORE: The effects of blockage on clad
14 temperature.

15 CHAIRMAN JENSCH: In other words, the answer to the
16 question is yes, that you assume that once it's bursting it's
17 going to stay within a two-foot area or two-foot length on the
18 rod, is that correct?

19 MR. MOORE: Yes, for that assembly.

20 CHAIRMAN JENSCH: Thank you, proceed.

21 MR. ROISMAN: I think your answer to our Question 18
22 you indicated that the ORNL document cited there was an older
23 document and since that time further tests or test had been
24 run on blockage of heat transfer, which indicate that in core
25 geometry interference will not affect the ECCS performance.

Are those the multi-rod bundle burst tests that you were referring to?

MR. MOORE: Yes. That was part of it. But I believe there was a question also there on the embrittlement. So there were other tests involved, too.

MR. ROISMAN: Embrittlement tests runs by Westinghouse, where are those tests? I mean what document? Is that in this document 7379?

MR. MOORE: Yes, I believe so. The single rod burst.

MR. ROISMAN: I am going to ask you to look at page 6 of that. I will hand you the document in a moment.

2.2.5.2, entitled Quench Testing of Irradiated Tubes and I will ask your counsel to look at it and see if we can talk about this paragraph in the open transcript or not.

All right? What I want to find out is some information about the parameters that were used in the quenching tests.

MR. TROSTEN: In these first two paragraphs under 2.2.5.2, is that correct?

MR. ROISMAN: Yes.

MR. WIESEMANN: That report is non-proprietary.

MR. TROSTEN: This is a non-proprietary report.

MR. ROSIMAN: It is? What does proprietary Class 3 mean?

MR. MOORE: Non-proprietary.

MR. ROISMAN: Well, I got some other hot ones in the office, too. You have got one called Proprietary Class 2. Is that also non-proprietary?

MR. MOORE: No, that's proprietary.

MR. ROISMAN: What about Class 1?

MR. MOORE: That's very proprietary.

MR. ROISMAN: And the higher the number goes the better it is. Class 4 means it's GE's report.

CHAIRMAN JENSCH: I don't know that it's better. There is more security on it.

MR. ROISMAN: Okay. Then can you take a look at this paragraph, these paragraphs here. You can sit down.

Now this test was run with rods that were heated at the rate of ten degrees Fahrenheit per second. Is that the heating rate that you would anticipate for rods in a loss of coolant accident?

MR. MOORE: That's one of the rates we can anticipate in a loss of coolant accident.

MR. ROISMAN: Which is the one that you used in your conservative evaluation of the ECCS performance?

MR. MOORE: It varies depending on the power of the rod and also the time during the transient. The rate of increase of the hot rod varies with time. If you look at the curve that shows temperature, which is time, you can see how the rate varies.

MR. ROISMAN: Does it go over ten degrees?

MR. MOORE: Yes.

MR. ROISMAN: How high does it go?

MR. MOORE: You get up into the adiabatic heat-up range, thirty degrees a second, forty degrees a second.

MR. ROISMAN: How does that affect the ability of the rod to withstand quenching, the rate at which it's heated up?

MR. MOORE: I don't recall that that was a strong effect. It was mainly the time at a given temperature

rather than the rate at which you reach that temperature.

MR. ROISMAN: The more time you spend at a given temperature what effect does that have on quenching?

MR. MOORE: The greater the metal-water reaction.

MR. ROISMAN: And therefore?

MR. MOORE: And therefore you get more chance of embrittlement, and in fact you maintain the clad at a high temperature for long periods of time as the data shows to give it metal-water reaction in excess of sixteen percent, then we can have an embrittled rod.

MR. ROISMAN: But for metal-water reaction you would not expect a rod to shatter or fall apart, if you will, as a result of exposure to a coolant, the emergency core cooling water, is that correct?

MR. MOORE: As long as you are below a local metal-water reaction of sixteen percent.

MR. ROISMAN: And let me just make sure I have your testimony correct. If you were to take a fuel rod that was end-of-life irradiated with heat-up rate of forty degrees Fahrenheit per second, heated it up for ten seconds at that rate and then without holding at the peak temperature at all but assuming that it was, because of this heating that occurred to it, it was then at a temperature of like 2000 or 2100 or 2200 degrees Fahrenheit, and dropped it into a pool of 140-degree temperature water that the

1 rod itself would not shatter as a result of that
2 temperature difference, assuming there is no metal-water
3 reaction on it?
4 MR. MOORE: You really confuse me. Could you
5 go back to the beginning? I was heating up the rod.
6 MR. ROISMAN: Yes. We are going to assume that
7 the rod, when we get through heating it up, is like
8 2200 degrees Fahrenheit.
9 MR. MOORE: At the end of the heat-up.
10 MR. ROISMAN: Right. And you can assume there
11 isn't any metal-water reaction on the rod, just for
12 purposes of first asking about this. It's got -- In
13 all of the respects it has happened to it what you would
14 expect to happen to it in a loss of coolant accident, which
15 I assume means that it's burst at some point before it
16 got there and the last ten seconds of its rise to 2200
17 degrees Fahrenheit it went up at the rate of forty degrees
18 per second Fahrenheit. You now drop it into a pool of
19 water that's 140 degrees temperature, is it your testimony
20 that the rod won't shatter?
21 MR. MOORE: There was no zirc-water reaction.
22 MR. ROISMAN: And I'm just assuming per our
23 reaction that there isn't any.
24 MR. MOORE: I wouldn't expect the rod to shatter.
25 MR. ROISMAN: Is the rate at which it's heated

1 up totally irrelevant to this or just forty degrees per
2 second is not fast enough to get it in the area of being
3 relevant?
4 MR. MOORE: I just don't feel that the rate
5 itself is relevant as long as we are ignoring zirc-water
6 reaction and time at given temperatures, that the rate
7 is irrelevant.
8 MR. ROISMAN: In doing the quench test here it
9 says "Three specimens were heated to test temperature
10 at a rate of ten degrees Fahrenheit per second and the
11 fourth was heated at a rate of five degrees Fahrenheit
12 per second. Do you know why those heating rates were used?
13 MR. MOORE: No, I don't.
14 MR. ROISMAN: Now the rods were held at a
15 temperature, so Table II informs us on page 7 of the
16 document, one rod was held at the 2400-degree temperature
17 for ninety seconds. Another at 2525 degrees for thirty
18 seconds. Another at 2595 degrees one second. And then
19 the rods were quenched. Now do you claim that it would
20 not make any difference if the heating rate for those rods,
21 assuming the same holding time, in other words now going
22 to the actual tests used here, assuming the same holding
23 times, that the heating rates had been forty degrees per
24 second Fahrenheit that we wouldn't have had any different
25 result?

MR. MOORE: No, no. Heating rate, if I have gotten certain water reactions the heating rate determines my temperature transient and I have got to integrate under that temperature transient curve to get the total amount of water reaction. That's the key point here, that the basis for these tests was to get different combinations of conditions which gave us different total metal-water reactions. So that if I went up to 2000 degrees and stayed there for a few seconds and did it very rapidly, versus going up to 2000 degrees and stayed there at a slow rate and stayed there for a few seconds I could get more metal-water reaction just because of the time I'm at a given temperature, so that I could continue to get a reaction.

MR. ROISMAN: You get more metal-water reaction by the slower temperature rate increases is what your testimony is, is that correct?

MR. MOORE: Yes. Let's go back to the premise. The basis for that is because I'm at temperatures for which I can get a reaction for longer periods of time.

MR. ROISMAN: Let's assume that the rod was at a temperature, was going through temperature transient for a period of sixty seconds. If it took it five seconds to get up to 2400 degrees Fahrenheit then it stayed at 2400 degrees Fahrenheit for five seconds, would you have more metal-water reaction than you would if it took sixty seconds to get up to 2400 degrees Fahrenheit?

MR. MOORE: Yes. I would have more if it was at 2400 degrees for a longer period of time. Then I would have more metal-water reaction.

MR. ROISMAN: Thus then the rate at which the rod heats up will eventually affect the metal-water reaction if we assume that the rod is exposed, isn't the temperature transient period for the same period of time?

MR. MOORE: Yes. That's a different condition we are talking about. Yes.

MR. ROISMAN: Well, I was just looking back here at Table 2, the first tube, which is identified as LY-27. It was heated at the rate of ten degrees per second until it reached 2400 degrees Fahrenheit. It was held at that temperature for ninety seconds and then it was quenched.

Assuming that it is going to be held at the peak temperature for whatever time is left after it gets heated up in order to come up with the same total transient time, do you follow me?

1 All right. This rod started off--

2 MR. MOORE: Why don't you go to the chart and draw

3 me the temperature versus time?

4 MR. ROISMAN: Because I'm not sure I could draw it.

5 This rod will, I guess, must have started at something like

6 room temperature or maybe it started at 600 degrees Fahrenheit.

7 I'm not sure if it tells you here. All right.

8 Assuming it started at 600 degrees Fahrenheit if

9 you took the temperature up to 2400 degrees at the rate of ten

10 degrees per second that would take a certain number of seconds

11 which I can't compute in my head and then it's at 2400 degrees

12 and you leave it there for ninety seconds. Now we have got

13 a total elapsed time from the time the temperature transient

14 began until the quenching takes place, just for simplicity's

15 sake let's say it's three minutes for the whole thing. Now

16 if that very same rod were heated up to 2400 degrees Fahrenheit

17 at the rate of 40 degrees per second and then held at the 2400

18 degrees Fahrenheit until the three minutes had expired, you

19 would have more metal-water reaction for that rod than you did

20 for the rod as done in the test, is that correct?

21 MR. MOORE: All other things being constant, yes.

22 CHAIRMAN JENSCH: Is this a convenient place to

23 interrupt your examination?

24 MR. ROISMAN: Just a couple of more questions.

25 Has a computation been made as to how long you'd

1 expect the hottest rods in the core to be at their peak
2 temperatures?
3 MR. MOORE: Certainly. That's the basis for cal-
4 culating the metal-water reaction.
5 MR. ROISMAN: And what is the maximum?
6 CHAIRMAN JENSCH: Wait a minute, wait a minute. I
7 wonder if we could get the question answered yes or no.
8 MR. MOORE: I said certainly. That's yes.
9 CHAIRMAN JENSCH: Thank you very much.
10 MR. ROISMAN: And what is that time, the longest
11 time?
12 MR. MOORE: For the double-ended rupture, cold leg
13 break, Figure 10 of the July 13th test showed the temperature
14 versus time for the hot spot in the core and it reaches 2300
15 degrees in about--peaks at eighty seconds and it's up over
16 2200 degrees for say sixty seconds, to give you an idea. It's
17 above 2200 degrees for sixty seconds.
18 MR. ROISMAN: Can you tell me from the chart at what
19 heat up rate that rod is assumed to be heating up? What is the
20 highest rate is's assumed to be heating up at?
21 MR. MOORE: Over that period of time I just mentioned?
22 MR. ROISMAN: No, I'm sorry. From the moment the
23 loss of coolant accident is initiated. I think you have total
24 time of about eighty seconds until it reaches the 2300 degree
25 Fahrenheit. Sixty of them you say are at temperatures of

1 around 2200 and above.

2 MR. MOORE: Right.

3 MR. ROISMAN: So it's about twenty seconds that it

4 took to get up to 2200 from 600.

5 MR. MOORE: No. Well, excuse me. I'm at 2200 in

6 about forty seconds. I'm just under. About fifty seconds

7 I'm at 2200. I'm below 2200 again in a hundred ten seconds.

8 MR. ROISMAN: And a very rough calculation would

9 suggest that if you were heating up at forty degrees

10 Fahrenheit per second in forty seconds you heat up 1600

11 degrees and the rod was approximately at 1600 degrees when it

12 started, so that figure, if that would be correct to assume,

13 assumes an average heat up weight of about forty degrees per

14 second.

15 MR. MOORE: That's an average heat-up rate.

16 MR. ROISMAN: Right. I did not mean to pin you down

17 to an exact figure.

18 MR. MOORE: If you look at the shape of the curve

19 you can see that the very rapid increase is early in time when

20 we go through D.N.B. and it tends to settle down and then the

21 rate of increase increases during the adiabatic heat up.

22 MR. ROISMAN: Just looking at the curve there do you

23 see any time there when the heat-up rate is ten degrees per

24 second or slower?

25 MR. MOORE: Yes.

MR. ROISMAN: How much time would that be? How much time at that rate, roughly?

THE WITNESS: Oh, thirty seconds.

Which point in time are you talking about?

MR. ROISMAN: Before the 2200 degrees, sorry.

MR. MOORE: Oh, no, I didn't see anything that was less than ten degrees a second.

MR. ROISMAN: Thank you, Mr. Chairman, this will be a good time to stop.

CHAIRMAN JENSCH: Just one question. Did you see anything in a curve that was at ten degrees per second?

MR. MOORE: At ten degrees per second, yes. That's what was confusing me. Later on after I reached 2200 degrees the slope reduced.

CHAIRMAN JENSCH: That is after you were at 2200 degrees you then went at ten degrees?

MR. MOORE: At less than ten degrees a second.

CHAIRMAN JENSCH: Thank you.

At this time let's recess to reconvene in this room this afternoon at two o'clock.

(Luncheon recess.)

1 A F T E R N O O N S E S S I O N

2 CHAIRMAN JENSCH: Please come to order.

3 During the morning recess I had a telephone

4 conversation with Mr. Egan, who is Assistant to Congressman

5 Dow of New York. We asked whether Congressman Dow could

6 appear this afternoon. He desired to make a statement.

7 We have been fortunate in having two statements from him

8 in two earlier sessions of the hearing. Today we were

9 favored with his presence and he would like to give an

10 additional statement.

11 If you would come up to the witness stand and

12 use the microphone, I'm sure the people in the room would

13 better be able to hear you. We understand from a

14 statement from Mr. Egan the last time, that you had

15 expressed concern after talking to some scientists, about

16 certain problems of nuclear power plants. We expressed

17 the hope that you would be able to hear some of the

18 evidence in the case so you might hear another side, if

19 there is something different than what you have heard.

20 We again invite you to participate in the proceedings

21 by your attendance.

22 If I may suggest, I'm sure the parties would

23 respond if you have some particular inquiries you would

24 like to have propounded. If you would ask one of the

25 parties or the Regulatory Staff -- When we run out of

1 opportunities of selection at this time, we always turn
2 to the Regulatory Staff. So if we run out of people who
3 can propound questions for you, try the Regulatory Staff.
4 If you have some specific questions seeking some facts
5 that will assist you in your consideration of the matter,
6 I'm sure they will be glad to cooperate. In any event,
7 we welcome you to the hearing.
8 MR. DOW: That's very kind of you, Mr. Jensch.
9 I'm really pleased to be here and to be received in such
10 an open-minded spirit as you have expressed.
11 My name is John G. Dow. I am the Congressman
12 for the 27th Congressional District, which is located so
13 that it wraps itself around the area where the Indian
14 Point plants are located. On the west side of the river,
15 I represent parts of Rockland and all of Orange County.
16 On the north side I represent Putnam County. So I would
17 think that if you drew a circle around the Indian Point
18 plants, that most of that area within the circle would
19 fall in my congressional district even though the plants
20 themselves are located in another district. So that's
21 why I have a concern about this.
22 I am going to read a brief statement. I think
23 I am going to bring up some points that are well known
24 to you. I believe that they deserve continued attention.
25 Mr. Examiner;

Dr. Ernest J. Sternglass, Professor of Radiation Physics at the University of Pittsburgh School of Medicine, and other scientists, have recently made a strong case that the low-level but continuous flow of radioactive materials discharged from a large nuclear reactor facility, whether vented as a gas, or in the cooling water, constitutes a potential health hazard of grave proportions. This hazard is particularly ominous in that young children and the unborn are much more sensitive to such low-level radiation than older people, and the amount of injury sustained by them is much greater. This difference has been well established by a number of studies. Unfortunately, even today most estimates of the effects of radiation from reactors are in terms of the effects on adults.

This year, Dr. Sternglass completed a study of the influence on infant mortality of radioactive emanations from nuclear reactors in the New York Metropolitan area. In the past ten years, the Con Ed plant at Indian Point has been one of the two largest sources of artificial radiation in the Metropolitan area.

Dr. Sternglass compared the infant mortality, that is the deaths in the 0 to 1-year-old age group, versus births, with the amount of discharge from the Indian Point reactor. The people in Rockland and Westchester Counties, living closes to the reactor, would be expected

to show effects more than people in more distant areas. In Rockland and Westchester, Dr. Sternglass found that the infant mortality rose from a pre-Indian Point value of 19.1 deaths per thousand in 1965, and 21.6 in 1966, which was the year of maximum radioactive discharge from the Indian Point plant. In other words, compared with 1961, a "quiet" year radioactively speaking, all later years showed infant mortality increases of between six and sixteen percent in Rockland and Westchester, until 1968 and 1969, when the mortality rate fell dramatically, correlated with a decrease in radioactive effluent from the plant. In 1969 the mortality rate was nine percent lower than 1961.

Moving to an area of population size comparable to Rockland and Westchester, but further from Indian Point, Dr. Sternglass checked the infant mortality in Duchess, Orange and Putnam Counties. Compared with the 1961 rate in these counties, infant mortality rose by one and a half percent in 1962, then fell, fanging from six to twenty-four percent below the 1961 value. In 1966, the year of maximum emissions from the reactor, the rate was eighteen percent less than 1961.

Still further to the north and west from Indian Point, in Columbia, Greene, Sullivan and Ulster Counties, an area forty miles and still further from the reactor, infant mortality here also dropped below its 1961 rate in most

1 years, being twenty-eight percent less in 1966. Again,
2 to the south, thirty to fifty miles from Indian Point in
3 Nassau County, infant deaths were down for half the years
4 after 1961, ranging from eight percent above to fourteen
5 percent below the 1961 value.

6 Dr. Sternglass would be the first to admit that
7 socio-economic factors help determine infant mortality,
8 and that the areas I just discussed are not strictly comparable
9 in this respect. However, he believes that the fluctuations
10 in the mortality rates we have seen are true manifestations
11 of changes in radiation levels, which in turn in recent
12 years have been largely determined by reactive discharges.
13 In New York City, which lies from fifteen to sixty miles
14 from Indian Point, infant mortality has been below its
15 1961 value in four out of the eight years since, ranging
16 from seven percent more in 1962 to ten percent less in 1968.
17 In 1966, the mortality rate in the City was three percent
18 under its 1961 value. Social, medical and pollution problems
19 of increasing magnitude in New York City have thus not
20 prevented the normal slow decline in infant deaths, which
21 we saw evident in all areas except those near the Indian
22 Point reactor.

23 It is clear, then, that relative to the normal
24 slow decline in infant mortality, Rockland and Westchester
25 Counties showed an excess of deaths for most of the last

1 ten years; in fact, in all the years the Con Ed reactor
2 was discharging permissable but nevertheless substantial
3 radioactive wastes. Dr. Sternglass demonstrates a precise
4 correlation between this excess mortality in Rockland
5 and Westchester, and the amount of radioactive
6 waste that was released.

7 Dr. Sternglass has studied the possible effects
8 of seven nuclear facilities in different parts of the
9 United States on infant mortality. His results have
10 generally been comparable to these on the Indian Point
11 reactor. Although his results are disputed by some
12 radiation experts and biologists, beyond dispute is the
13 abysmal failing we have demonstrated in resolving this
14 problem, and continue to demonstrate, in the face of the
15 great seriousness and the great threat to the well-being
16 of society which Dr. Sternglass and others claim. The
17 failing is our continual avoidance of the issue, our
18 unwillingness to examine wholeheartedly and impartially the
19 effects of living with these giant nuclear reactors.
20 Society's problems are large and many, yet here is one
21 which is not only of vast importance, but seems particularly
22 amenable to scientific analysis. We in the U.S.A. are good
23 at scientific analysis. Yet we have not applied it here,
24 where it is critically needed.

25 Most unfortunately, the low-level radiation from

1 reactor discharges may work in an insidious, largely
2 unseen way. We are obliged to think of generations
3 beyond our own. Increased incidence of childhood
4 leukemia and cancer, more stillbirths and congenital
5 malformations, greater frequency of premature births with the
6 resultant susceptibility to illness, more genetically
7 caused weakness and disease in future generations must be
8 contemplated. This is the payoff which Dr. Sternglass
9 and others see for us in a nuclear age. Is it true?
10 What steps can be taken to prevent it? Have we
11 honestly balanced the costs and benefits of large reactors
12 in populated areas?

13 Until these questions are answered -- And it is
14 the responsibility of AED to answer them. -- I urge that
15 we postpone all construction which will add to our nuclear
16 burden. Until the AEC fully understands and protects us in
17 the situation, and guarantees that it does, all construction
18 should be halted.

19 Our electric power could be rationed, if need be,
20 to provide further time in which to solve this serious issue.
21 We all see so much excessive power outpouring in trivial
22 electric advertisements, over-lighting of motels merely
23 to get attention and in innumerable wasteful uses of power,
24 that a little restraint in power use can well be afforded.
25 The gravity of this issue is not the possible lack of power,

1 it is the failure so far to provide a conclusive assessment
2 of dangers posed by nuclear radiation. No verdict has
3 been returned. That must come first before anything else.
4 I thank you, Mr. Examiner.
5 CHAIRMAN JENSCH: Mr. Congressman, we appreciate
6 you taking the time to come here and give us your
7 statement. I know you realize that your statement does
8 not constitute evidence because you are not available
9 for cross-examination. Or are you?
10 CONGRESSMAN DOW: I will be glad to answer
11 questions if that's what you mean by cross-examination.
12 I surely would.
13 CHAIRMAN JENSCH: Let me ask you another question.
14 Do you suppose you could get Dr. Sternglass to come here
15 and be subject to cross-examination?
16 CONGRESSMAN DOWN: Yes. He would be delighted,
17 I'm sure. I know him quite well.
18 CHAIRMAN JENSCH: Will you endeavor to see if
19 he would?
20 CONGRESSMAN DOW: Sure, I will. You bet.
21 CHAIRMAN JENSCH: The only reason I say that,
22 I don't know anything about what he has represented in
23 his statement. I understand he has appeared in some other
24 cases and there has been some cross-examination of him.
25 CONGRESSMAN DOW: Since he has written a paper

which does reflect the radiation here at this Indian Point plant, I think it would be very germane to get him here. He is quite an impressive fellow. I think you would like him. I will try to arrange for it. You will be here for two weeks, will you?

CHAIRMAN JENSCH: Yes.

CONGRESSMAN DOW: Good. I will work on that and see if we can't get him here.

CHAIRMAN JENSCH: Would you care to look at a transcript of his examination? I think he was in some case somewhere around this region. I had forgotten the name.

MR. KARMAN: He testified last week at the Columbia case in Washington.

CHAIRMAN JENSCH: There was some other case in Long Island or something.

MR. KARMAN: He testified at the Shoreham case.

CHAIRMAN JENSCH: Would you care to read the transcripts of his cross-examination and come back and give us a further statement after you have read his cross-examination?

CONGRESSMAN DOW: I don't mind doing that. I think that since we might be able to get him in the flesh, that would be better. Let's try to do that.

CHAIRMAN JENSCH: I'm sure a lot of people would

like to see him in the flesh and have a chance to visit with him.

CONGRESSMAN DOW: You know, Mr. Examiner, I realize very well when I read this paper, that Dr. Sternglass is probably not in a majority. In fact, he may be pretty lonely in his position. Not entirely, but somewhat. Yet, in the course of history, you know there have been very many lone men who proved to be right. I think you will realize that.

CHAIRMAN JENSCH: No reflection of the fact that he may turn out to be right at all. It is just a question of, in a sense, Dr. Sternglass' statement in this record. I imagine people will think it is evidence when, of course, it isn't.

In fairness to the people who will be interested in the Indian Point plants, his statement in a sense shouldn't be really received by us as evidence unless he is willing to be cross-examined.

CONGRESSMAN DOW: I am not presuming to elevate my statement to the level of evidence.

CHAIRMAN JENSCH: Whatever it be, we are glad to have it, Congressman Dow.

CONGRESSMAN DOW: Thank you. I will do my utmost to arrange for Dr. Sternglass to be here. I think it would be very salient.

CHAIRMAN JENSCH: Let me inquire. Is there anybody in the case who would like to interrogate Dr. Sternglass?

MR. TROSTEN: Mr. Chairman, may I make this general observation? On behalf of the Applicant, we are very pleased to see Congressman Dow present and to hear his statement. May I suggest the possibility that rather than having Dr. Sternglass brought here to offer testimony in this proceeding, perhaps he could come and make a statement in the nature of a limited appearance similar to the statement that Congressman Dow was making. On the other hand--

CHAIRMAN JENSCH: I understand he made the same statement. Did Dr. Sternglass you these data that you have submitted?

CONGRESSMAN DOW: Yes. These are extracted from a paper that he gave me. This was an elaborate paper with graphs and all that sort of thing in it. This is an extract, you might say.

CHAIRMAN JENSCH: Do you want it in double, in spades?

MR. TROSTEN: No. I believe I understood the Chairman to be saying that Dr. Sternglass be called as a witness. I was merely suggesting, Mr. Chairman, that rather than having him called as a witness, I presume as a witness called by the Board, that he simply come, if he is to come, and offer a statement by way of limited appearance, if that is his desire and Congressman Dow's desire.

CHAIRMAN JENSCH: Maybe he would also, even, as a

limited appearance, if that is his desire and Congressman Dow's desire.

CHAIRMAN JENSCH: Maybe he would also, even as a limited appearance person, be willing to answer any questions.

MR. TROSTEN: Possibly.

CHAIRMAN JENSCH: Would you be interested in asking him some questions.

MR. TROSTEN: I guess it would depend, Mr. Chairman, on what Dr. Sternglass had to say at the time. We would have to make that decision at that time. Perhaps we might have some questions to put to Dr. Sternglass.

CHAIRMAN JENSCH: My only point is, I'm sure that people who will read this transcript will unfortunately--a charge has been made about radioactivity levels. Until that is answered some way, it may leave an incorrect impression upon the public if the statements by Dr. Sternglass are well founded. I know he has made a study. I don't know what it is. I make no comment about its value or veracity or his willingness to be cross-examined.

MR. TROSTEN: Perhaps I could offer this suggestion, Mr. Chairman: As you know, in this particular proceeding, none of the Intervenors have raised the question as to the effects of low level radioactive releases from the Indian Point 2 plant on public health and safety. This is not an issue in this contested proceeding. As far as the general question

of the effect of low level releases from another plant, not the Indian Point 2 plant, which of course is not in operation at the present time, but the effects of low level releases from the Indian Point 1 plant, as a matter of general information, I am glad to comment on that point at this time in response to what Congressman Dow has said.

CHAIRMAN JENSCH: I am sure Congressman Dow would be interested, too, because I think he is openminded and wants to hear whatever information there may be.

CONGRESSMAN DOW: That's right.

MR. TROSTEN: I'd be glad to make a comment. I am very glad, as I say, on behalf of the applicant, to have an opportunity to address the Congressman in this respect.

Of course, the Indian Point 1 plant has been operating for some time, the releases from this plant have been well within the permissible releases authorized by the Atomic Energy Commission.

CHAIRMAN JENSCH: When you mention releases authorized by the Atomic Energy Commission, where did the Atomic Energy Commission get the levels that are set up in Part 20? I think Congressman Dow would be interested.

MR. TROSTEN: The basic radiation standards which are embodied in 10 CFR 20, are based upon advice received from a body of groups. These groups include the NCRP--

CHAIRMAN JENSCH: What is that?

1 MR. TROSTEN: The NCRP is a federally chartered
2 corporation--
3 CHAIRMAN JENSCH: What is that?
4 MR. TROSTEN: The NCRP is a federally chartered
5 corporation--
6 CHAIRMAN JENSCH: A national committee?
7 MR. TROSTEN: You're absolutely correct, a national
8 committee on radiation protection. This is a body of out-
9 standing scientists. In this body is combined the expertise
10 in this country and all the disciplines associated with
11 radiological protection. This body has been involved since,
12 I believe, 1929, in the matter of advising the agencies of the
13 Federal Government and the medical profession and the cognizant
14 authorities generally in this country and abroad on matters
15 of radiological health and safety. In addition to drawing upon
16 the expertise of the NCRP, the Atomic Energy Commission has
17 also drawn on the expertise of the ICRP, which is the
18 International Committee on Radiological Protection, which is an
19 international body similar to the NCRP which has participated
20 in the formulation of radiological health and safety protection
21 standards for some several decades.
22 Drawing upon the expertise of these and all other
23 bodies, the Atomic Energy Commission, including the Federal
24 Radiation Council, the Atomic Energy Commission has promulgated
25 its health and safety standards for releases from nuclear power

1 plants which are embodied in 10 CFT part 20. The Indian
2 Point 1 plant has not been permitted to make these low level
3 releases within the standards established by the Atomic
4 Energy Commission, and as a matter of fact, the releases from
5 the Indian Point 1 plant have been far, far below the standards
6 authorized by 10 CFR Part 20.
7 There have been questions raised by Dr. Sternglass
8 and there have been questions raised by the people from time
9 to time in the past, as to whether or not these exceedingly
10 low level releases from the Indian Point 1 plant might con-
11 ceivably have contributed to an increase in infant mortality,
12 or mortality generally, and in one case, I believe, the
13 question was raised as to whether an increase in certain
14 types of cancers was caused within the locale of the Indian
15 Point 1 plant as the result of these exceedingly low level
16 releases.
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There have been a number of studies made of this. The New York State Department of Health has made two studies to the best of my knowledge. Perhaps there have been others. It is specifically related to the question of increase in cancers resulting from releases from the Indian Point-1 plant. This study was performed by the New York State Department of Health in connection with the Indian Point-3 construction hearing, and it was made public and is included in congressional hearings held on this subject.

More recently in response to questions raised by Dr. Sternglass, the New York State Department of Health published a document entitled, "Health Statistics, 1962 to 1969," for counties in New York State having nuclear facilities. The net effect of this study is to conclude that there has not been the type of problem which Dr. Sternglass believes may have existed here. If I may quote very briefly from the summary of this study, it reads as follows: "Results of this study indicated no significant deviations between counties with nuclear facilities and those without for characteristic study. Wide fluctuations and observed rates occurred between counties within as well as in each county over the decade."

It goes on in this general vein for several paragraphs discussing the subject.

1 CHAIRMAN JENSCH: May I interrupt? Would it be
2 possible for you to give a copy or get a copy and give
3 it to Congressman Dow? I'm sure he would be interested
4 in reading the New York State report that is dealing
5 particularly with this subject. Would you be interested?
6 CONGRESSMAN DOW: Of course I would be.
7 CHAIRMAN JENSCH: Could you get an extra copy
8 and give it to Congressman Dow for Dr. Sternglass?
9 Maybe he would be interested.
10 CONGRESSMAN DOW: He should have it.
11 CHAIRMAN JENSCH: Could you get two copies, one
12 for Congressman Dow and one for Dr. Sternglass?
13 CONGRESSMAN DOW: That would be fine.
14 MR. TROSTEN: Mr. Larsen will deliver the copy
15 I have in hand to Congressman Dow. We will see that a
16 copy is sent to Dr. Sternglass.
17 CHAIRMAN JENSCH: If I may suggest it, send
18 it to Congressman Dow and he will turn it over to Dr.
19 Sternglass. Would that be all right?
20 CONGRESSMAN DOW: I believe I have one here; is
21 that correct? This is the document you are speaking of.
22 MR. TROSTEN: You have before you, sir, the
23 New York State study.
24 CONGRESSMAN DOW: That's the one you were
25 considering to send to me; is that correct?

1 MR. TROSTEN: Yes.

2 CONGRESSMAN DOW: Fine. All right. Well, I
3 will make this available to Dr. Sternglass.

4 MR. TROSTEN: This would be fine. Just one
5 other general observation with regard to Dr. Sternglass'
6 observations. That is that, as the Congressman observed,
7 there certainly is considerable dispute within the
8 scientific community, apart from the pure matter of
9 statistics, as to the validity of Dr. Sternglass'
10 conclusions.

11 I am personally aware of sessions of the
12 Health Physics Society, I believe. You will have to
13 excuse me. I am speaking as a lawyer and not as a
14 scientific witness.

15 CHAIRMAN JENSCH: In this field there is no limit.
16 Proceed.

17 MR. TROSTEN: -- in which exceedingly grave
18 doubts were expressed as to the validity and conclusions
19 drawn by Dr. Sternglass.

20 So just to sum up, I would say that I believe the
21 Indian Point-1 plant has certainly operated well within
22 the limits permitted by the applicable regulations of the
23 Atomic Energy Commission. These regulations having been
24 set up on the basis of the best scientific advice, and on
25 the basis of the best evidence available to the Applicant

1 and to the cognizant governmental agency, there appears
2 to be no substance whatsoever to the claim by Dr. Sternglass
3 that there has been an increase in mortality in this
4 general area.

5 CONGRESSMAN DOW: Could I make a comment?

6 CHAIRMAN JENSCH: Yes.

7 CONGRESSMAN DOW: I think one point that is
8 disturbing to us is the fact that Dr. Sternglass says --
9 And I'm sure you would agree, sir -- that there has been
10 no breach that we know of of the permissible radiation
11 from this Indian Point complex. Apparently from
12 Dr. Sternglass' statement, there has been an increase of
13 this infant mortality rate in the environs of the plant,
14 even within the permissible limits. I think that is
15 perhaps the point that might be emphasized here.

16 I am not, and in my position, it is pretty
17 hard to judge the technicalities of this situation, the
18 mathematics of it, the physics and all the rest of it
19 that is involved. It is very difficult. I don't have the
20 time and I don't have the capacity. I am concerned, as
21 a representative of the public, about some aspects of
22 this whole radiation problem that are still very much
23 in controversy.

24 I read an article in the New York Times magazine
25 section that took the Atomic Energy to task in paragraph

after paragraph yesterday because of a rather cavalier, apparently cavalier dealing with the problem of radioactive sands which are offshoots of the mining process in Colorado. This makes you doubt the care with which the Atomic Energy Commission is monitoring these situations.

Not long ago there was a judge that shut down a plant or put some kind of a stop on work on a plant down in Maryland which was not apparently being set up with the safety standards that good judgment would require. In that case the judge chastized the AEC.

CHAIRMAN JENSCH: Congressman Dow, may I interrupt? Would you like to meet the attorney sitting here at the table, Mr. Roisman, who has some familiarity with that?

CONGRESSMAN DOW: I will continue. That's fine. There is a panel of scientists in the Boston area who recently issued a paper showing deep concern for the possibilities of a radioactive accident within one of these installations. That was the subject of my last paper that I filed with your group, Mr. Examiner.

So there seems to be no answer to this thing. We don't get conclusive answers. I went before the Joint Congressional Committee on Atomic Energy, and I raised the question with them, what is the final answer, what kind of an indication can we have that really tells us

1 these are safe, and why they are safe, and can we rely
2 on it. He said, Congressman, we have had testimony on this.
3 We have had stacks of testimony. I will show them to you.
4 He pointed to a pile of books on this. He said,
5 we have been doing our job. But out of it all has come
6 no conclusive definitive answer that seems to resolve
7 these questions. These questions deal with the future of
8 our people. They deal with genetic implications, to say
9 nothing of the immediate possibility of infant mortality.
10 So that in my appearance here, Mr. Examiner,
11 I'm not really seeking to delve into particular nuts and
12 bolts of this plant. I am using this as a forum, frankly,
13 to raise this question that has got to be raised constantly
14 in every situation of this kind. I don't say the Indian
15 Point plant is any worse than any other plant. But I do
16 say that we face this question. It is not being answered
17 for us. The AEC hasn't answered it. The Joint Committee
18 on Atomic Energy in the Congress hasn't answered it. We
19 have this constant interchange of disagreement.
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At the same time we are going ahead with installations that might prove very serious and very dangerous for us in the future. That's why I am here, to raise the question. If somebody can give us a definitive answer and conclusion, thank God, I'd say.

I know that you people would like to offer lots of evidence and documentation to convince me that this plant is safe. I wouldn't be able to understand it, Mr. Examiner. I just want an answer to the question.

CHAIRMAN JENSCH: Congressman Dow, if you will excuse me, if I may say with humility, I certainly think you should be complimented for your close interest in this matter. I think the fact that you have followed some of these current events affecting atomic energy shows your close interest. I'm sure I speak for all the attorneys here. If there is anything that any of the attorneys can present to you out of this case, they will be glad to do it to keep you informed about it, and to also invite you back for any further statement you would like to make.

CONGRESSMAN DOW: Thank you. You have been very cordial.

CHAIRMAN JENSCH: I might say offhand that your assistant, Mr. Egan, has represented you very well in your absence, but we would like to have you personally, too.

CONGRESSMAN DOW: It just happened I was free today,

1 Mr. Examiner, and glad to come. I would be glad to read or
2 receive any data that is within my level of scientific
3 capability, which isn't very high. I will be glad to receive
4 anything that will shed some light on this, look into some-
5 thing definitive that the American people can rely on.
6 CHAIRMAN JENSCH: And to which they are entitled.
7 CONGRESSMAN DOW: Yes, indeed they are.
8 CHAIRMAN JENSCH: Thank you, Mr. Dow.
9 CONGRESSMAN DOW: Very good.
10 (Applause.)
11 MR. ROISMAN: Inasmuch as Mr. Trostenhas spoken as
12 a lawyer, technician, and I'm sure the Board wants to have as
13 much of the record straight, I would like to add to his state-
14 ment, a couple of points in the nature of a limited statement
15 on this question of radioactivity.
16 CHAIRMAN JENSCH: Will you do that, and also cover--
17 Congressman Dow, Mr. Egan, if you are not too much in a hurry,
18 I would like you to hear the statement of Attorney Roisman.
19 He is the gentleman that has had quite a bit to do with this
20 Maryland project. I am sure he will give you information
21 that might be interesting to you. I wish you can, Mr. Roisman,
22 discuss the radioactivity statement to which the Congressman
23 has referred.
24 CONGRESSMAN DOW: I will be glad to. I can't stay
25 too long but I will stay a minute.

CHAIRMAN JENSCH: He won't be too long, I'm sure. Thank you, Congressman Dow.

CONGRESSMAN DOW: I'm glad to stay.

MR. ROISMAN: Mr. Trosten mentioned the NCRP and ICRP, which are two radiation protection councils. Part of what they had done is to determine that the dosage to which the average person should be subjected during the course of the year--and I stress the use of the term "important" that it is something like five rems and they take into account a certain amount of background radiation that we are all subjected to, medical sources, and radiation that we might get from sources such as nuclear plants. From that computations have been made that the amount of radioactivity that you should get from a plant such as a nuclear power plant should be something like 0.5 rems, or, in other words, one-tenth of the annual dosage. Then there has been some dispute among those organizations and some disputes between the AEC and other organizations as to whether the figure should be 0.5. In other words, 500 millirems or 170 millirems.

There is a body of expert opinion in the country that argued that the figure should be 170 millirems instead of the 500 millirems which the AEC has used traditionally.

In addition, those figures are average figures. They don't take account of unusual existence of background radioactivity in a special area.

As the Chairman knows, we discovered in Vermont that there is a portion of the State of New Hampshire that has an unusually high amount of background radioactivity.

CHAIRMAN JENSCH: You knew what that was.

MR. ROISMAN: What the amount of radioactivity was?

CHAIRMAN JENSCH: In New Hampshire, in Grafton.

MR. ROISMAN: You knew I wasn't going to travel there.

CHAIRMAN JENSCH: I think this is something, but it it something like 400 rems. There is some water level in Grafton, New Hampshire, that the International Committee on Radiation Protection will convene immediately as soon as they hear that. Maybe they have cast iron constitutions. They are all living up there.

Will you proceed, please?

MR. ROISMAN: Of course, those factors differ. One of the points that has been made by not only by Dr. Sternglass but Drs. Gofman and Tamplin who had been concerned with this problem, is that you need to make some analysis of the special environment in which the plant might exist to find out whether the total dosages of the people in the area might exceed the five rem figure in the course of the year due to the exposures, outdated equipment. It might increase what the medical dosage might normally be expected in that area.

In addition, certain segments of the population are

susceptible to the radioactivity than others. There is some evidence that has been compiled by scientists in England to suggest that the children are more susceptible to these radioactive doses than adults. That seems to be particularly associated with the thyroid of children.

Studies have been done to show that the same dosage level of children may produced a more adverse effect than that dosage level would be if it were received by an adult.

1 In addition, pregnant mothers, particularly
2 during the first trimester, are more susceptible to damage
3 to the fetus as a result of radioactive exposure than
4 are other members of the population. So that the average
5 figures that we often talk about are assumed for the
6 perfect average man and doesn't even include the average
7 woman.
8 And that is an important qualification to the
9 statement about the safety of proposed radioactivity levels.
10 Most significant these, I think, particularly in mind with
11 what Congressman Dow said about concerns with the Agency,
12 and I like to believe that as the Chairman has referred to,
13 B.C., that is before Calvert Cliffs represented maybe
14 a different commission with a different attitude on some
15 of these matters than the post-Calvert Cliffs commission,
16 in that after many years of argument from doctors like
17 Sternglass and Gofman and Tamplin, that the radioactivity
18 level that the Atomic Energy Commission had authorized
19 was too high. The Atomic Energy Commission itself has
20 now proposed to cut that radioactive level by 100 and
21 reduce it to one percent of the proposed levels, which
22 on the one hand is encouraging to know that we are moving
23 in the direction of lower doses and on the other hand
24 is in the minds of many people confirmation that doctors
25 Gofman and Tamplin and Sternglass maybe had something

1 right along, because we know the AEC wouldn't require an
2 idle act of reducing radioactive releases to these one
3 percent levels.
4 And it's my understanding that the levels that
5 are being proposed are levels which the Indian Point No. 1
6 plant has not always met, although I believe the Applicant
7 is convinced that it's capable of meeting it with certain
8 types of administrative controls. But even at the one
9 percent level it's been my understanding that some technical
10 people have found that that level isn't necessarily a
11 reliable level because the releases from the plant have
12 to be translated into doses to people, and making the
13 translation depends upon using things such as biological
14 concentration factors, which are ways in which we trace
15 the radioactivity as it moves from the plant through the
16 various animals or plants in the environment, through
17 the food chain, and eventually to man.
18 Assumptions are made as to what the biological
19 concentration factors will be, and based upon those
20 assumptions it's assumed that if you release X amount
21 of radioactivity at the plant no person is going to
22 receive more than Y amount of dose from it.
23 But there is a lot of doubt in the biological
24 concentration factors, and as a hedge against that the
25 AEC requires a very extensive monitoring program by which

there is a doublecheck on the biological concentration factor to see whether in fact you are getting doses that are higher than were predicted.

A flaw, I think, in that whole analysis is that the monitoring occurs every place but, if you will, the target animal. They are not monitoring people. We don't know whether in fact slipping through all of the monitoring there still isn't an excessive dosage to individuals.

I take it that the statistics that Dr. Sternglass has attempted to compile in several plants are one way of attempting to examine the target animal, and I imagine that we could argue about whether there wouldn't be better or more preferable ways to go about doing that sort of statistic, but it's directed at what we are all concerned with, which is people.

But finally, I think this is the most important point that Mr. Trosten didn't mention, and that is that the N.C.R.P. and the I.C.R.P. and as far as I understand it the responsible members of the Atomic Energy Commission and really the entire radiological technical field, that there is no clearcut conclusive evidence that there is a safe lower level of radioactivity, a level below which we can safely expose the public. They believe that they have no evidence that there is a level that is now being

1 used that is high enough to be dangerous, but it's kind of
2 a question of burden of proof. Is the public entitled
3 to be exposed to radiation only after it's been proven
4 that it's clearly safe or are they to be exposed to it
5 until it's proven that it's clearly dangerous? And I
6 think it's at that point that Drs. Sternglass and Gofman
7 and Tamplin and people such as the Con Ed and the
8 responsible people at the Atomic Energy Commission differ.
9 That's a deep, important, philosophic difference that
10 exists, but it's an important one to keep in mind, that
11 all the returns aren't in yet. We don't know conclusively
12 what the effects of this radioactivity is on people, and
13 of course some of them are potential genetic effects,
14 which means that you can even pick it up in a single
15 generation or within a single group of people.
16 I think that that's why there has been such a
17 controversy about this issue. Dr. Sternglass maybe is
18 the man who has been out in front and taken the most heat
19 on the issue. I guess that's because his figures, if they
20 are correct, are the most startling, and despite, I know
21 and am aware, of extensive criticism of his position by
22 other reponsible scientific people, it shouldn't becloud
23 the fact that the issue is still very serious. It's still
24 very much in doubt, enough in doubt that even the Commission
25 is now acting to reduce radioactivity levels by 100 times

1 what they had been before.

2 MR. TROSTEN: Mr. Chairman, may I make one

3 other brief observation?

4 CHAIRMAN JENSCH: Yes.

5 What is the average release at Indian Point-1 too,

6 if you are going to speak? Do you know what they have

7 there, what the average release is?

8 MR. TROSTEN: Mr. Cahill can give you an

9 approximation.

10 CHAIRMAN JENSCH: Well I have in mind Mr. Roisman

11 talked about the fact that there is some dispute whether

12 it should be 500 millirems or 170 millirems. What has

13 been the release from Indian Point-1, do you know?

14 MR. CAHILL: Well, the 500 millirems is the

15 Atomic Energy Commission's regulatory limit. I believe the

16 170 is the AEC's regulatory limit for large segments of

17 the population.

18 Now the Indian Point releases when converted

19 to equivalent doses are for gaseous releases, the order

20 of about one percent of what is allowed for gaseous

21 releases. On the liquid, the releases to the water

22 environment, they have been average five or six percent

23 over the life of the plant. And as Mr. Roisman mentioned,

24 Con Edison is taking steps, both administrative and

25 physical steps, to permit the plant to do better than that.

Recently, that is in the last few years or year or so ago, the Commission put forth a concept that radioactive releases from nuclear plants should be as low as practicable.

Now our company has followed that policy for many years before this concept was promulgated and had taken steps to put additional purification systems into Indian Point-1 to, in effect, achieve lowest practicable releases before any requirement was put forth by the Commission.

Now this one percent that Mr. Roisman mentioned is a proposed definition of lowest practicable radiation releases that has been promulgated by the Commission. But to summarize we have in the past averaged releases that are only small percentages of the so-called part twenty limits.

CHAIRMAN JENSCH: Will you proceed.

You are aware that Congressman Dow is graciously sitting here and he said he would sit for a short statement.

MR. TROSTEN: Yes. I will endeavor to make this very short.

There has been a scientific disagreement going on for several years now as the Congressman has observed. Just a footnote to the discussion that we have had this afternoon, this might be worthwhile, is the fact that the NCRB recently concluded a year's long study of the standards that had previously been in effect and concluded as the result of this lengthy study that the standards previously promulgated were essentially satisfactory.

Another matter of significance, I think, from the Congressman's point of view, of course, is under the recent reorganization of establishing the environmental protection agency that the responsibility for setting the ambient radiation standards is now resting in EPA with the Atomic Energy Commission now remaining responsible for the setting of the Commission standards in general compliance with the standards set by EPA.

So there will be an independent check made as the result of this reorganization.

CHAIRMAN JENSCH: Thank you very much Congressman Dow for staying. We are glad to note your presence and hope

you will come back again.

CONGRESSMAN DOW: Mr. Examiner, just let me say that I want to thank these gentlemen for their comments and if the sense of responsibility that they are manifesting here carries over into the conclusions of your examination I think that we will be further along on the track toward the objective.

I myself feel that I want to keep everybody's feet to the fire as much as I can so that ultimately we will feel safe about points we have arrived at, and I hope it will be in the near future.

CHAIRMAN JENSCH: I am sure that your concerns will be well noted by all parties, and we hope you will keep informed of the progress of this case. I thank you for coming, Congressman.

CONGRESSMAN DOW: Thank you.

MR. KARMAN: I'd also like on behalf of the Regulatory Staff to congratulate Congressman Dow for showing such an intense and continuing interest in the Indian Point 2 plan on behalf not only of his constituents, but obiously on behalf of himself as well. And you may rest assured that we have been going at this hearing now for almost a year and that ever facet of the matters relating to the health and safety of this plant certainly will be considered by this Board.

CONGRESSMAN DOW: Thank you. I am glad to hear that, Mr. Examiner.

1 Might I inquire who this gentleman is that made
2 this statement about the Calvert Cliffs?
3 CHAIRMAN JENSCH: This is Mr. Anthony Roisman, the
4 attorney for the appellant in the proceeding before the
5 Court of Appeals of the District of Columbia that handed down
6 a decision on July 23rd, I believe, that has been heard around
7 the world.
8 CONGRESSMAN DOW: It's good we have him here.
9 Now who is Mr. Roisman representing here today?
10 CHAIRMAN JENSCH: He will speak to the title. I
11 seem to get these environmental defense groups confused.
12 MR. ROISMAN: Congressman, in this proceeding I am
13 representing two organizations with regard to the matters
14 of radiological safety. I represent the Citizen's Committee
15 for the Protection of the Environment, which is an organiza-
16 tion based in this area, but with national interests, and
17 with regard to the environmental matters I represent the
18 Environmental Defense Fund in this proceeding. We haven't
19 gotten to the environmental matters yet, but we shall.
20 CONGRESSMAN DOW: I thought I could understand your
21 testimony better if I knew who you were representing. Thank
22 you. It's been a great pleasure and thank you, Mr. Examiner.
23 CHAIRMAN JENSCH: We appreciate your coming.
24 Are we back to further examination of Mr. Moore?
25 Are you ready for further interrogation?

MR. ROISMAN: Yes, Mr. Chairman.

CHAIRMAN JENSCH: Before we do, there has been a gentleman sitting here this morning by the name of George Arcaro who had prepared a written statement. I understand he has distributed it to all of the parties. He would like to have it incorporated as a limited appearance statement. Is there any objection by the Applicant?

MR. TROSTEN: We have no objection to it being incorporated as a limited appearance statement, Mr. Chairman.

CHAIRMAN JENSCH: Regulatory Staff?

MR. KARMAN: We have no objection, Mr. Chairman.

CHAIRMAN JENSCH: Environmental Defense Fund.

MR. ROISMAN: No objection.

CHAIRMAN JENSCH: Hudson River Fishermen's Association?

MR. MACBETH: No objection.

CHAIRMAN JENSCH: Very well. The statement of George Arcaro as presented here may be incorporated within the transcript as if read and this constitutes a written statement by limited appearance participants within the scope of the rules of the Commission.

Very well, let us proceed.

(Document follows:)

CHAIRMAN JENSCH: Mr. Moore has returned to the stand.

MR. ACARO: Mr. Chairman, if you please, I didn't want simply to file it. I would like to have some response to the issues I raise.

CHAIRMAN JENSCH: Well maybe when we have had a chance to study it and the evidence may reflect your response and a limited appearance person can file his statement as you have done and we have noted it as the rules provide. Thank you for coming.

Mr. Moore is back on the stand. Are you ready to proceed, Mr. Roisman?

MR. ROISMAN: Yes, Mr. Chairman.

Mr. Moore, let me direct your attention to Question 26. In that answer you indicated that there had initially been some difficulty or possible difficulty thought to exist by simulating blockage by the use of flat plates and that the Idaho Nuclear Corporation had simulated rod blockage by the use of tapered plates which showed roughly the same kinds of effects that had been shown with the flat plates, and your terms in effect verify the earlier tests done with flat plates for blockage and I was wondering whether blockage as it actually occurs and a loss of coolant or simulated loss of coolant accident would in your opinion be any different than blockage which is simulated either with the tapered plates or with flat

1 plates. If not why not?

2 MR. MOORE: I feel the blockage to be expected under

3 the loss of coolant conditions is described by the kinds of

4 geometries we saw in the multi-rod bursts and these would be

5 qualified I think more as a tapered kind of a blockage than

6 a flat plate sharp-edged orifice type of blockage.

7 So the tests performed at Idaho I think were more

8 representative. The results showed, however, that this wasn't

9 a significant consideration.

10 MR. ROISMAN: Maybe I am not seeing this, but

11 are there any experiments that have been run to determine how

12 fuel rods are actually cooled if there is a blockage in the

13 channel where the blockage is one that was actually created

14 in the rod rather than one that was simulated with the use of

15 a tapered or a straight plate?

16 MR. MOORE: To my knowledge I don't know of any

17 specific tests of rods which were deformed as burst rods and

18 then the test made for each, no.

19 MR. ROISMAN: I gather Westinghouse has a number of

20 these or had at one time a number of these rods around with

21 bursts and swelling in them as the result of the single rod

22 and the multi-rod tests that were done. Do you know why no

23 tests were ever done to see whether the flow of water would

24 actually move around those rods in the way that the flow

25 blockage analysis has been made?

end

1 MR. MOORE: Well, the main concern is to get
2 a representation of the heat generation within these
3 rods, to get appropriate heat transfer situations, and
4 also to get good measurements of what the heat transfer
5 effects are.
6 So if you have got the kinds of geometry that
7 obtain after a rod burst situation, it's difficult to
8 control and maintain the prescribed heat rates in the rods
9 and get the right measurements so that you know what
10 you have got.
11 MR. ROISMAN: What about time to run coolant
12 through the rods while you are bursting or swelling them?
13 Has any thought been given to doing that?
14 MR. MOORE: No. We think the approach where
15 we were able to define, separate and define the problem
16 was the one where we'd get better information on it. That's
17 the main reason.
18 MR. ROISMAN: The reason that I asked the
19 question, not on your drawing on the board up there, but
20 I have seen the little pictures in the various documents,
21 this Oak Ridge National Lab 3645 and the Westinghouse
22 analyses, and one thing that struck me was the lack of
23 uniformity in the way the rods acted. That is every one
24 of them didn't bulge exactly the same way. Some of the
25 bulges were fat in the middle and then they tapered off

very quickly and others were tapered much greater than that. And it didn't appear from any of the tests that there was any standard, that they could always say, "Well, this rod will always break this way and that rod will always break some other way," and I am wondering as to whether or not the tests of coolant flow, if they are taken using simulated blockage with these tapered plates or with the straight plates how that is able to accurately determine what the flowage is going to be, given that there is such an irregularity in the way that the rods do swell and burst.

MR. MOORE: Well, I think you can look at it as being -- Looking at two kinds of extremes. The plate, flat plate wituation where you have very abrupt changes in flow area may be represented above a very sharp burst situation. That's the test we performed and the test that was performed by Idaho Nuclear had a tapered situation without any abrupt changes in flow area, which were represented above the more gradual bursting or swelling situation that we see.

The interesting results were that it really didn't make much difference with either of those extremes and they were two different extremes. So that the conclusion was the exact geometry of the reduction of flow area per se was really not critical. And on that

1 basis you don't get concerned about the exact representation
2 of these geometries.
3 Remember also that all of these tests that I
4 referring to, the Idaho test and our test, indicated that
5 heat transfer was approved with flow blockage for which
6 no credit was taken. It wasn't as if we had an adverse
7 effect here and really had to figure out whether we could
8 be even worse off. In both cases the results showed an
9 improved heat transfer situation.
10 MR. ROISMAN: But those were all in cases
11 where at least one channel was open for the rod to be
12 cooled through, isn't that correct?
13 MR. MOORE: As has been observed in all of the
14 flow blockage tests that I am familiar with.
15 MR. ROISMAN: I think my concern really was that
16 flat plates versus gradually tapered plates, like what
17 you had objected to and I had asked you a question with
18 only an either/or in it and there was yet a third case.
19 I'm concerned about lumpy, irregular, unpredictable kind
20 of blockages such as the kind that the swelling and
21 bursting tests have shown are the way the rods will in
22 fact deform.
23 But I gather that your testimony is that a check
24 of how the coolant will operate for rods with those types
25 of swelling and bursting hadn't been done. What had been

1 done is one set of tests with the tapered blockage and
2 another with the flat plate, and those are the only kind
3 that you are aware of.
4 MR. MOORE: That's correct. But again with
5 both of those extreme cases there were still beneficial
6 effects so that if the results had come out in a way
7 that the taper had been a penalty and the flat plate had
8 been of benefit, then I think we would have had a more
9 difficult problem. And the real question as to how should
10 we simulate the actual situation. But that did not become
11 the case, because the general effect was the same with
12 totally different geometries.
13 MR. ROISMAN: Let's follow that for a second.
14 You are saying that you took into effect two ends of the
15 spectrum; both of them showed favorable results let's say
16 low on the scale, and neither of them were high and from
17 that you assume that noplace in between would the result
18 be high.
19 MR. MOORE: Not exactly. I would say also by
20 looking at movies of what happened, looking at movies
21 of the situations and the flow we found out that the large
22 water droplets were being broken up in both cases and
23 this atomization effect was the kind of thing that was
24 giving me the benefit of heat transfer.
25 And you fully expect to get that atomization

1 effect in most geometries as well.

2 MR. ROISMAN: Maybe you can explain to me a

3 little bit about what causes the atomization to take place

4 where there is blockage that doesn't cause it to take

5 place when you have just got normal open channels.

6 MR. MOORE: It's the change in the flow area

7 itself which tends to break up the drops by changes in

8 acceleration, pressure drop, so forth.

9 MR. ROISMAN: Do you mean that in a given channel

10 as the water moves up between the rods if the water is

11 impeded in its flow so that it has to flow around some other

12 way, that that change in direction is what tends to break

13 up the water?

14 MR. MOORE: That's part of it, when you change

15 direction.

16 MR. ROISMAN: And what if the water didn't

17 get by the channel at all? In other words, it either

18 didn't enter the channel in the first place because of

19 blockage in the channel or entered the channel and then

20 it just sort of got jammed up in there and it had to go

21 out and to a different rod altogether? Would you have the

22 same effect?

23 MR. MOORE: Yes. I believe there were some of

24 these FLECHT tests we performed have a few channels which

25 were completely blocked 100 percent with adjacent channels

which weren't fully blocked and so there was this kind of a flow bypassing, and the water was broken and good heat transfer was observed even downstream of the fully-blocked area. This was a small channel. A number of channels, I forget the number, were fully blocked. That was seen.

MR. ROISMAN: And when you say downstream of the blocked channel, in other words you mean above the blockage?

MR. MOORE: Above the blockage.

MR. ROISMAN: What was transferring the heat out of that channel?

MR. MOORE: Just the turbulence and the steam water that was coming around the blockage and then coming back in downstream was sufficient to carry the heat away.

1 MR. ROISMAN: In question--well, let me wait and
2 look at the transcript on that. I am not sure that I under-
3 stand your answer.
4 Question 37, I think you testified there with a peak
5 clad temperature of 1500 degrees Fahrenheit less than twenty-
6 five per cent of the rods would experience distortion. What
7 kind of distortion were you talking about there?
8 MR. MOORE: That less than twenty-five per cent of
9 the rods would in fact burst.
10 MR. ROISMAN: What about swell but not burst?
11 MR. MOORE: You could get some swelling. I don't
12 have a number for percentage of them swelling in that case.
13 MR. ROISMAN: Swelling, going back again, to the
14 flow blockage question, swelling is worst than bursting for
15 that purpose, at least if the swelling occurs over a long
16 period.
17 MR. MOORE: I guess not necessarily. You can get
18 swelling configuration which are worse than bursting and
19 vice versa.
20 MR. ROISMAN: Just to pin a figure down, what per-
21 centage of rods will burst if their temperature reaches
22 2300 degrees Fahrenheit?
23 MR. MOORE: Any rod that reaches 2300 degrees
24 Fahrenheit bursts.
25 MR. ROISMAN: And is there some place in the

1 submissions by the Applicant that you could direct me to that
2 indicates what percentage of fuel rods are at specific
3 temperatures following the double-ended pipe break, cold
4 leg?
5 MR. MOORE: I don't believe so. That's an out-
6 standing item I have from this morning to find that rod
7 census. I don't know if it's in the file documents or other-
8 wise. I know we have the figures. I will have it tomorrow.
9 MR. ROISMAN: Okay, Mr. Chairman, that's all I have
10 for Mr. Moore at this time. I would like to ask Mr. Wiesemann
11 a couple of questions about his answer on Question 36.
12 CHAIRMAN JENSCH: Proceed.
13 Mr. Moore, you are temporarily excused, subject to
14 call for further examination.
15 MR. TROSTEN: Before Mr. Wiesemann commences his
16 response, I would just like to have the record show that in
17 response to a question that was raised by Mr. Roisman this
18 morning concerning the points of contact of the rods with the
19 grid, that we have shown Mr. Roisman a photograph of the
20 grid which appears in the FSAR 3.2.3-10, which I understand
21 to be responsive to his question.
22 CHAIRMAN JENSCH: Very well. We may proceed.
23 MR. ROISMAN: Yes, Mr. Chairman.
24 MR. TROSTEN: Mr. Wiesemann, Question 36 had to do
25 with the predicted level of radioactivity released from the rods.

1 We were comparing the results of the Oak Ridge National Lab
2 4635 test with the predicted levels for this plant and I
3 believe that you testified that what was actually released in
4 the Oak Ridge test was substantially less than what had been
5 established and predicted for this plant. Can you tell me
6 what effect the fact that the Oak Ridge National Lab used a
7 rod with only thirdy days of power activity in it would have
8 had upon the amount of activity released from the rod?
9 MR. MOORE: That would have affected the inventories
10 available for disposition of any kind. In other words, the
11 total amount of radioactivity. However, my comparison was
12 based upon comparing the percentage or the amount released
13 compared to the total that was there.
14 In other words, for example, of the total iodine
15 releases there was about .2 per cent of the inventory that
16 was actually in the rod was released. You compare this to
17 fifty per cent that is assumed to be released, this is the
18 number prior to making any assumptions on plate-out, which
19 gives you the factor of a hundred difference.
20 In other words, the only effect that we normalize,
21 I should say normalize to the total amount of activity that
22 was in the rod.
23 So that in Indian Point we are taking fifty per
24 cent of everything that's in the rod as far as the iodine,
25 total iodine is concerned, and fifty per cent with the total

1 inventory, which is a much bigger inventory, we recognize, and
2 this is compared to about .2 per cent of the total inventory
3 that was in the rod in the Oak Ridge tests.
4 If we had applied the same percentage that was
5 observed in the Oak Ridge tests to the Indian Point situation
6 we would have resulted in doses that were approximately a
7 factor of a hundred lower.
8 MR. ROISMAN: Is the amount of activity, is the
9 percentage of activity released in any way depending upon how
10 old the rod is, how long it's been in the reactor?
11 MR. MOORE: That shouldn't affect the percentage,
12 the percentage release, if one assumes that the transient
13 that occurred simulates reasonably well the expected loss of
14 coolant accident situation with the temperatures of the rods
15 which would affect the transport of activity that one would
16 expect the appropriate results.
17 In other words, the fraction that came out would be
18 representative of the fraction you'd expect to come out,
19 regardless of the inventory.
20 MR. ROISMAN: Does the point at which the rod bursts--
21 I don't mean the point in time, physical location on the rod--
22 does that affect the amount of radioactivity that would be
23 released from the rod? For instance, if it burst at the bottom
24 and or at the top end or, you know, some place along the line?
25 MR. MOORE: I would not expect that to have a

1 significant effect. In the analysis we assume that all of the
2 activity that's in the gap, for example, in other words, if you
3 look at what would be expected to be actually released from
4 these few rods, recognizing as we have been discussing here
5 that the upper limit of clad damage is the rupture of the cladd-
6 ing, and that the temperature transient of the reactor itself
7 turned around relatively quickly, that essentially all of the
8 activity released is that activity which is stored in the space
9 between the metallic cladding of the fuel and the fuel pellets
10 themselves.

11 Now, in our assumption where we use gap activity for
12 a basis of calculating the exposure, we simply assume that all
13 the activity that's in the gap is released. However, in the
14 actual situation one would expect some of that activity to
15 remain within the fuel rod, just simply because of the fact
16 that all of the gases that are in the rod are not expelled when
17 the rod comes to equilibrium with the surrounding atmosphere.

18 Now in the case of the other types of assumptions
19 that are analyzed we go far beyond that, taking into account
20 releases that are way beyond the amount that would be contained
21 in the gaps, and which is a sense is a very conservative thing.

22 I think we discussed that at an earlier session of
23 the hearing, about the conservative nature of those assumptions.

24 MR. ROISMAN: Well, in terms of the amount of
25 activity that comes out of the rod will it be affected by the

1 amount of pressure that builds up in the rod before the rod
2 actually bursts? In other words, if it builds up to a
3 higher pressure before it bursts will more activity come out
4 of the rod than would happen if it burst with a lower internal
5 pressure?

6 MR. MOORE: I guess the way I would put it is that
7 as the pressure, initial pressure was assumed to be lower the
8 amount of activity, the amount by which our assumed activity
9 would be conservative would become larger and larger.

10 For example, if you took an extreme situation,
11 assumed that the pressure inside the fuel rod, just for a
12 hypothetical situation, was at the same pressure that the
13 reactor was going to come to ultimately in transient, that
14 there would be no release of the activity other than by
15 simple diffusion, because there would be no pressure grading
16 to distribute this.

17 Well, as you raise the pressure in the rod higher
18 and higher the fraction of fission gases that will be expected
19 to remain within the rod gets to be smaller and smaller and
20 it approaches the least conservative assumption that was used
21 in the analyses of the off-site consequences of this accident
22 for the Indian Point plant.

23 MR. ROISMAN: That's all the questions I have at
24 this time, Mr. Chairman. Unless we have something else to
25 take up, I would assume that the staff has questions, I would

just as soon s- this transcript and then do further cross-examination, particularly of Mr. Moore, tomorrow.

CHAIRMAN JENSCH: Does the Staff have any questions?

MR. KARMAN: Not at this time, Mr. Chairman.

CHAIRMAN JENSCH: Hudson River Fishermen's Association?

MR. MACBETH: No.

CHAIRMAN JENSCH: Any redirect?

MR. TROSTEN: Not at this time, Mr. Chairman.

CHAIRMAN JENSCH: Well, let us consider. What if we can take a recess at this time to reconvene here at 3:40 and we will have a chance incidentally in this recess to read Mr. Arcaro's statement and maybe the Board would desire to submit some questions to the parties for their consideration of this regard? At this time we will recess to reconvene in this room at 3:40.

(Recess.)

CHAIRMAN JENSCH: Please come to order. Mr. Briggs has some matters he would like to discuss with the parties.

MR. BRIGGS: Mr. Arcaro provided us with a statement in the nature of a limited appearance. Mr. Arcaro, I would like to say at the beginning, I recognize that the nuclear reactor business can be a very difficult one for people who aren't close to it. We make a vocabulary all our own. We have terms that seem that only we understand sometimes, and we sometimes don't understand those very well. So I was rather concerned in reading the statement that you have here that there are some things that aren't very well understood, and I'd like to ask that the Staff Counsel and the Staff witnesses that we have here, and maybe with some help from others, try to explain some of the differences.

The first one that I refer to here is the concern that a loss of coolant failure can lead to a meltdown of the nuclear fuel which is certainly true, and in turn to a devastating nuclear explosion.

Could someone from the Staff comment on this, please? Is it possible for a meltdown of the fuel in this reactor to lead to a nuclear explosion?

MR. KNIEL: My name is Karl Kniel. Well, a meltdown from this reactor, to my knowledge, can't create

1 a critical mass so you can't have a nuclear explosion.

2 MR. BRIGGS: Are there reactors in which this

3 could happen?

4 MR. KNIEL: There aren't any water-cooled

5 power reactors proposed where this could happen. There

6 is some potential for it happening in a fast breeder type

7 of reactor.

8 MR. BRIGGS: Have you read the statement? Have

9 you had an opportunity to read it?

10 MR. KNIEL: Yes, I did read the statement.

11 MR. BRIGGS: It talks about Dr. Teller's

12 speech and about fast breeder reactors. In the context

13 of what you are saying, is there a possibility in a

14 typical fast breeder reactor for a meltdown to lead to

15 a nuclear explosion?

16 MR. KNIEL: I'd like to stick with my previous

17 statement, that to the effect that there is some potential

18 for it in a fast breeder reaction. I don't care to add

19 to that because I'm not particularly versed on the latest

20 developments in the fast breeder field.

21 MR. BRIGGS: You say that there is not that

22 potential in a water-cooled reactor; is that right?

23 MR. KNIEL: That's correct.

24 MR. BRIGGS: Is there some fundamental difference

25 between the two that should make it different in potential?

MR. KNIEL: Yes. The main difference between the two is the fast breeder uses a highly enriched uranium 235 fuel or a plutonium 239 fuel. So that you have a highly enriched core consisting, to a large extent, of fissile material. In a water-cooled reactor you have a very low enriched fuel. So that the amount of fissile material is much less.

There is too much natural poison in the mixture to create a critical mass. It is too low on density.

MR. BRIGGS: If there is no concern about a nuclear explosion from a meltdown, what is the major concern about a meltdown?

MR. KNIEL: The major concern from a meltdown will be the potential release of all the fission products that have been generated in the reactor during its previous operation prior to meltdown.

MR. BRIGGS: Then there was one other point here at the very end. It says, "After this article was written, the AEC reversed itself and today we learned it granted a temporary permit to operate plant No. 2."

Could you tell us something about the restrictions on the operation of plant No. 2 that are contained in this permit?

MR. KARMAN: Mr. Briggs, the permit or operating license which was issued to Consolidated Edison as

1 authorized by this Atomic Safety and Licensing Board,
2 was for fuel loading and subcritical testing. At no time
3 under the license which was issued, is the plant to go
4 critical.
5 MR. BRIGGS: If it doesn't go critical, what
6 about the radioactivity in it?
7 MR. KARMAN: There is none.
8 MR. BRIGGS: No fission production?
9 MR. KARMAN: There are none.
10 MR. BRIGGS: Mr. Arcaro, do you understand then
11 that the Staff at least believes that there can be no
12 nuclear explosion in a meltdown of a plant like this?
13 Can you accept that?
14 MR. ARCARO: I heard the testimony on Mr. Kniel.
15 I would only like to ask him that in the Fermi reactor
16 there was not plutonium fuel in a meltdown. Would he
17 like to explain that?
18 MR. KNIEL: In the Fermi reactor, it is a fast
19 breeder type of reactor. It didn't have a meltdown of
20 the core. There was some melting of one fuel somewhere,
21 as I recall. But that is a fast breeder reactor whereas,
22 I said, potentially there is some possibility of having
23 a reassembly of material so that you could have an explosion.
24 MR. ARCARO: It was a loading of U-235, though?
25 MR. KNIEL: That is correct.

1 MR. ARCARO: Which is the same kind of fuel
2 you are using here?
3 MR. KNIEL: But the enrichment was different.
4 Here the enrichment has a maximum of five percent. In a
5 Fermi reactor the enrichment in the fuel is ninety-three
6 percent, which is pretty close to the kind of thing that
7 presumably is used in bombs. You can't make a bomb with
8 five percent enriched material, is what I am saying.
9 MR. ARCARO: May I ask further?
10 CHAIRMAN JENSCH: Sure, go ahead.
11 MR. ARCARO: In a meltdown, how can you tell,
12 as Dr. Edward Teller says, where the flow will go, if
13 you can predict it in exact fashion? How can you tell
14 where it will flow and realize that a critical mass of
15 U-235 is less than ten pounds or less than the size of
16 two golf balls, that this kind of mass can explode?
17 MR. KNIEL: I am not trying to say, in answer
18 to your question at the moment, what happens to a fast
19 breeder type of reactor. What I am trying to say is that
20 there is so much poisonous material that is poisonous
21 to neutrons, and material in a lighter water reactor --
22 So even if you have a meltdown, you can't assemble it into
23 a critical mass.
24 CHAIRMAN JENSCH: When you say light water reactor,
25 you are talking about the kind at Indian Point?

1 MR. KNIEL: That is correct.

2 CHAIRMAN JENSCH: And that's all we really

3 are concerned about in your statement, what is happening

4 in Indian Point. A light water reactor doesn't have the

5 fuel that permits it. Dr. Teller is talking about an

6 entirely different type of reactor, a different fuel.

7 He conceives a different result.

8 In any event, I don't think there is any

9 disagreement, as I understand the Staff's statement, that

10 a light water reactor cannot produce results that you are

11 worried about. Do you have anything that concerns you

12 further in that regard?

13 While there is a pause and you are looking, I

14 wonder if I could ask the Staff about this first part of

15 Mr. Arcaro's statement. He said there were six straight

16 failures in atomic reactors to coolant cells in

17 emergencies, called loss of coolant failures. I could

18 ask Mr. Arcaro, where did you get the information? Are

19 you referring to the experimental tests that were undertaken

20 at Idaho for the purpose of determining what would happen?

21 They wanted to know what would happen, and these were

22 experiments. Or is it your thought that something that

23 has been licensed for power generation in this country

24 had this problem?

25 MR. ARCARO: It was reported in the Standard Star

of New Rochelle as being apparently six tests. As I say, as a result of tests, not operating plants, that showed possible basic design defects in nuclear fuel reactors. They reported that on May 25th --

CHAIRMAN JENSCH: The next paragraph was the one I was referring to, six straight failures in atomic reactors. As I understand it, there is no licensed atomic power generating facility that has had any failure to cool themselves, because it hadn't been an emergency.

MR. ARCARO: Did it fail to cool down?

CHAIRMAN JENSCH: No. They suspended operation with a partial meltdown of a subassembly. Is that correct?

MR. KNIEL: Yes.

MR. ARCARO: There are several cases out west.

CHAIRMAN JENSCH: Where?

MR. ARCARO: Give me a moment and I will look them up.

CHAIRMAN JENSCH: Please do.

MR. ARCARO: These are hearings before the Atomic Energy Commission. I'm sorry. It is apparently a joint committee of Atomic Energy, one of which they report the Fermi reactor failure to cool down.

CHAIRMAN JENSCH: They didn't even reach the point of cooling, did they, Mr. Kniel?

MR. ARCARO: They tried to.

CHAIRMAN JENSCH: That's different.

MR. KNIEL: What happened at the Fermi reactor, to my recollection, is that there was a partial meltdown of one fuel assembly. There was no release of activity, essentially no release of activity outside of environment. What activity was released was contained in the containment building.

MR. ARCARO: The whole testimony was that the coolant failed to flow because of a piece of cladding which fouled the flow of coolant in the Fermi reactor.

MR. KNIEL: That's true, there was some obstruction of coolant flow in one assembly.

MR. ARCARO: It was a loss of coolant failure, wasn't it?

MR. KNIEL: No. It was a partial obstruction of the coolant flow to one of the assemblies which resulted in a partial meltdown of the assembly.

MR. ARCARO: A partial loss of coolant?

MR. KNIEL: No, a partial obstruction of flow. The obstruction was part of the reactor that came unglued in a lower plenum and obstructed the flow to one of the assemblies. As a result of the obstruction of flow, the flow was inadequate to keep that particular assembly cool. So it was a partial melting in that assembly.

CHAIRMAN JENSCH: But the rest of the plant was

being cooled with respect to the core; is that correct?

MR. KNIEL: That's right.

CHAIRMAN JENSCH: And the reactor shut the whole thing down; is that correct?

MR. KNIEL: That's right.

CHAIRMAN JENSCH: There is one other thing, if you are looking for some data. If you are referring, Mr. Arcaro, to some tests that were undertaken in Idaho at a laboratory, to find the coolant activity in an emergency, you can be sure that subject is going to get very thorough examination in this proceeding. We invite your attendance during the course of the evidence. Rather than take it from the New Rochelle paper or the Long Island Sun, whatever it is, I think you will find the evidence here a little more specific and more directed to your real inquiries. Can you come and attend?

MR. ARCARO: I will be most glad to attend.

CHAIRMAN JENSCH: I'm sure there isn't a single person in this proceeding or party in this proceeding that isn't going to be extremely interested in every bit of the evidence that will be developed about the laboratory tests as related to what it may or may not have a relationship to this proceeding. That is a matter that you will want to know about, and we invite you to attend. If you can carry the word back to the New Rochelle paper from this

1 hearing, it might be a little helpful in understanding that.

2 Is there any other matter that you would like

3 to discuss, Mr. Arcaro?

4 MR. ARCARO: With respect to loss of coolant?

5 CHAIRMAN JENSCH: Loss of coolant will take up

6 the rest of the hearing. I wouldn't want to discuss it

7 this afternoon.

8 MR. ARCARO: Other matters I would like to present

9 further written material on.

10 CHAIRMAN JENSCH: We have your statement and

11 we thank you for submitting it. We will see that it is

12 made a part of the statement.

13 MR. ARCARO: Thank you, Mr. Chairman, and

14 Mr. Briggs.

15 CHAIRMAN JENSCH: At this time, if there is

16 nothing further, and I hear no suggestion, let us recess

17 and reconvene in this room tomorrow morning at nine o'clock.

18 (Hearing adjourned at four p.m.)

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