NUCLEAR REGULATORY COMMISSION

ORIGINAL

In the Matter of:

LOUISIANA POWER AND LIGHT COMPANY

(Waterford Steam Electric Station, Unit 3)

DOCKET NO. 50-382

DATE: April 1, 1982 PAGES: 1810 thru 2031

AT: New Orleans, Louisiana

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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| In the Matter of: | ) | |
| | ) | |
| LOUISIANA POWER AND LIGHT COMPANY | ) | Docket No. 50-382 |
| | ) | |
| (Waterford Steam Electric Station, Unit 3) | ) | |

Room 223, East Courtroom
Court of Appeals Building
600 Camp Street
New Orleans, Louisiana

Thursday,
April 1, 1982

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

BEFORE:

SHELDON J. WOLFE, Chairman
Administrative Judge
Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

DR. HARRY FOREMAN
Administrative Judge
Box 395, MAYO
University of Minnesota
Minneapolis, Minnesota 55455

DR. WALTER H. JORDAN
Administrative Judge
881 West Outer Drive
Oak Ridge, Tennessee 37830

APPEARANCES:

On behalf of the Applicant, Louisiana Power & Light Company:

SHAW, PITTMAN, POTTS and TROWBRIDGE
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On behalf of the Regulatory Staff:

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On behalf of the Joint Intervenors:

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-and-

LUKE FONTANA, Esq.
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C O N T E N T S

| WITNESSES | DIRECT | VOIR DIRE | CROSS | REDIRECT | RECROSS | BOARD EXAM. |
|---|---|---|---|---|---|---|
| DR. CARL JOHNSON | | | | | | |
| By Mr. Jones | 1831 | | | | | |
| By Mr. Turk | | 1837 | | | | |
| By Mr. Blake | | | 1847 | | | |
| By Mr. Turk | | | 1983 | | | |
| By Mr. Jones | | | | 2008 | | |
| By Judge Foreman | | | | | | 2023 |
| By Mr. Blake | | | | | 2028 | |

E X H I B I T S

| NUMBER | IDENTIFIED | RECEIVED | WITHDRAWN |
|---|---|---|---|
| Joint Intervenors': | | | |
| No. 13 | 1837 | | 1843 |
| No. 14 | 1837 | 1844 | |
| No. 15 | 1837 | 1846 | |
| No. 16 | 1837 | 1846 | |

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PROCEEDINGS

9:00 a.m.

JUDGE WOLFE: All right, Mr. Jones.

MR. JONES: Your Honor, Mr. Turk has just advised me that there's a matter that he wishes to report to the Board on, and I believe it would be appropriate for him to do so at this time.

JUDGE WOLFE: All right.

MR. TURK: Earlier in the proceeding the Licensing Board asked whether the Staff would be supporting the Applicant's motion for reconsideration of the sua sponte issue, and in addition the Licensing Board asked that copies of the Oak Ridge National Laboratory Draft Report be provided to the members of the Licensing Board.

At this time I do have copies of the Oak Ridge Draft Report and I would like to distribute them to the parties and the members of the Licensing Board at this time.

I would note for the record that it is only a draft report. It is not a final statement.

It may in fact be revised at some point, and I submit it with that caveat in mind.

JUDGE WOLFE: All right, thank you.

MR. TURK: In addition, the Staff has advised

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me from Washington that we will be supporting the Applicant's motion for reconsideration of the sua sponte issue, and we will be submitting a written filing as soon as possible in order to accomplish that.

It's my understanding that the statements contained in the Applicant's motion are in fact correct, that the Rowsome Report to the ACRS Subcommittee was later effectively retracted.

I understand also that the Subcommittee of the ACRS will be going before the full ACRS tomorrow on April 2nd to report its conclusions concerning the issue.

I can't really tell you much more about the Staff's position at this time except that we will be supporting the Applicant's motion.

JUDGE WOLFE: And when do you anticipate that Staff's supporting brief will be submitted?

MR. TURK: I am meeting on Monday in Washington with members of the technical staff who are involved with this issue.

At this time I would hope that we can come up with something next week. I can't guarantee that. It may be the early part of the following week.

JUDGE JORDAN: Will you be able, also, to provide expeditiously copies of the ACRS actions that are taking place this week?

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You mentioned, was it this week?

MR. TURK: Yes.

JUDGE JORDAN: The Subcommittee, if there is any information on that, it will be very helpful.

MR. TURK: Okay. I will make a sincere effort to do that.

MR. JONES: Your Honor, if I might have just a moment to address the Board's sua sponte issue or contention, however it's phrased.

I would like to ask the Board for leave for the Joint Intervenors to be allowed to file a motion in opposition to LP&L's motion, which I understand is now concurred in by the Staff.

We originally received the materials which have given rise to the Board's concern approximately on the 20th of February, I believe, and at the time it appeared to us that this was something quite new, and from the viewpoint of members of the general public, a matter of grave concern.

In fact, there was discussion among the Joint Intervenors, the Operating Committee that represent the technical expertise to the extent the Joint Intervenors can be credited with having expertise, as to whether or not Joint Intervenors should frame a contention or try to raise this as an issue on their own.

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In view of the proximity of the hearings which we now find ourselves in, the decision was made that we would not raise the issue; nevertheless, when Your Honors took it upon yourselves to raise the issue, we felt that our initial judgments in the question had been vindicated.

We perceive the question of the feed-and-bleed issue and its underlying bases, the fundamental assumptions or the fundamental findings of the NRC Staff on which this issue lies, to be matters of utmost importance to members of the general public, who as I'm sure you all appreciate we are really here as the surrogate representatives for.

Accordingly, we believe that this is a matter which should be fully and completely explored, and that the, if you will, the unopposed motions of Applicant now concurred in by Staff will not give this profoundly important issue the proper opportunity to be heard.

Accordingly, we would like to request that the Board provide us with guidance as to when we would be expected to provide a brief summarizing our position on the subject.

I would suggest we can either do one of two things. Based on the Applicant's motion, we can provide a response at the same time that it is anticipated that Staff's response will be filed; or alternatively, we can take a few extra days in order to address ourselves to

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matters raised both by Applicant and Staff.

We would do either at the pleasure of the Board.

JUDGE WOLFE: Any comments from the other parties with regard to Joint Intervenors' request for leave to file response to Applicant's motion for reconsideration.

MR. BLAKE: Yes, Judge Wolfe.

First, I feel it necessary to observe that it is my view that Counsel for Joint Intervenors in fact speaks for parties that he has identified in this proceeding and not as a surrogate of the general public at large, any more than any other party does.

He represents an identified party in this proceeding and has been allowed to appear in this proceeding on that basis.

JUDGE JORDAN: Would you repeat that? I didn't hear the last part.

MR. BLAKE: Only an observation with regard to Mr. Jones' comment that he speaks as a surrogate representing the general public, my observation being that he represents identified parties, and that's been the basis upon which he's been admitted to this proceeding.

Now getting to the heart of the motion, I have no objection to and quite frankly had anticipated

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that Joint Intervenors would respond to our motion on the time frame allowed within the Commission's regulations.

Our motion was served by hand on March 26th. Under Section 2.730 of the Commission's regulations, responses to that motion by the Joint Intervenors would be due ten days later and responses from the NRC Staff would be due, at least under the conventional numbers in the regulations, 15 days later.

JUDGE WOLFE: That would put Mr. Turk's response, supporting response, when? This was filed on the 26th?

MR. BLAKE: By my reckoning, Mr. Turk's would be due on the 12th of April, because the 15-day period would expire on the 10th of April, which is a Saturday.

Mr. Jones' response, by ten days, would be due on April 5.

I, however, would not oppose a reasonable extension of time for Joint Intervenors, recognizing that Mr. Jones has been here in fact each day and involved in the hearing; but by saying a reasonable period of time, because of the other constraints that we're operating under, which is an April 20 filing date for testimony if in fact our motion is denied by the Board and we need to address this issue.

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So a determination of whether or not we're going to have to has got to be made some time in advance of that date, so that the parties will know whether or not to file testimony on it.

As I've already indicated to the Board, we are marching along on that parallel path anticipating, so that we will be in a position to address it, in the event our motion is denied.

So in summary, I have no objection to a response. I would anticipate a response from Joint Intervenors.

While the rules would call for that response to be due on April 5, I would have no objection to an extension of time, either to later in that week, or in fact to the same date when the Staff's response would be due, which is April the 12th.

On the other hand, when Mr. Jones used the expression that he wants to file a motion, I woul oppose.

Of course, he can file a motion whenever he wants, but I would anticipate that I would object to another motion which requires additional responses, all incorporated in the same subject.

I think his opportunity to address it by way of response to our motion ought to be sufficient under

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these circumstances.

JUDGE WOLFE: Mr. Jones, would you clarify?

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MR. JONES: To the extent I may have misused the term "motion," it, in fact, was my intention to convey to the Board the fact that Joint Intervenors do wish to file a response to the Applicant's motion, rather than a separate motion.

My reference initially to the motion was within the time frame immediately following our receipt of the NRC's materials dealing with the feed-and-bleed issue.

Obviously, the Board's sua sponte motion has supplanted that, and that was the context in which I was using the term "motion." At this point the only thing that we are seeking to do is to obtain leave and a directive from the Board as to an appropriate date in which to file the response to the Applicant's motion.

MR. TURK: Perhaps I can undertake to --

JUDGE WOLFE: Just a moment, Mr. Turk.

Do I understand you to say that you'd like to file your brief or response -- apparently in opposition to Applicant's motion for consideration sometime after the Staff files its supporting brief, inasmuch as the Staff will be adverting to some action by the ACRS, for example? Is that what you're saying?

Or are you saying that yes, you would be able to file your response on or before April 12?

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MR. JONES: Your Honor, we would look to file a response, given the very tight time constrictions that we're working with here, on or before April 12. And to the extent that there may be something in the ACRS documents that would cast a substantial change in the factual picture, I believe we might request leave to amend our response. But --

JUDGE WOLFE: To do what?

MR. JONES: To the extent that the materials that the Staff will be providing us -- assuming that we cannot receive them in some timely fashion -- would vastly and substantially change the fundamental positions that the parties now find themselves in.

We would ask leave of the Board merely to supplement our response. Our response in chief, I'm quite confident, can be delivered to the Board before -- and no later than April 12.

JUDGE WOLFE: And one additional question: Is it your present intent to file any direct testimony with regard to the Board's sua sponte questions by express mail on April 20th?

We gave you that option, that --

MR. JONES: I realize that, that it was permissive rather than mandatory.

And I have not had the opportunity to make a

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determination in that regard. As Your Honor can appreciate, my entire intentions for about the last 30 days have been focused on what has been going on at this point in time.

I would advise the Board as soon as I am aware, one way or the other, of what that decision will be. And I would anticipate also that that decision would be made within the next week or so.

JUDGE WOLFE: Well, certainly you have up to April 20th to make that decision. You don't have to advise us previously. I was just interested in whether it was your present intention --

MR. JONES: I don't --

JUDGE WOLFE: -- and you don't know --

MR. JONES: It's beyond my comprehension at this point, Your Honor, what our capabilities and resources in that direction would be.

JUDGE WOLFE: All right. Mr. Turk -- Did you have something more, Mr. Blake, before we go to Mr. Turk?

MR. BLAKE: No, sir.

JUDGE WOLFE: All right.

MR. TURK: In an effort to help Mr. Jones prepare his filing by the 12th, I will undertake to have our filing served by express mail by Wednesday of next week, the 7th of April, barring any circumstances of which I'm not

aware now we will do so.

If something arises, I will quickly advise the parties and Licensing Board that we will need more than the time -- till next Wednesday to file. But I anticipate at this point that we should be able to get that off by express mail by the close of business next Wednesday, the 7th of April.

JUDGE WOLFE: And next Wednesday is April 7?

MR. TURK: Yes.

Incidentally, I only want to note that I am unaware of anything that Mr. Jones may have been referring to when he states that in February he called this issue to the attention of the Licensing Board or the parties.

My understanding is that the first time that the issue was called to anyone's attention was the Staff's serving of its Board notification on the parties and the Board on March 2nd.

MR. JONES: If my memory serves me correctly, Your Honor -- and I won't vouch for that at this point in time -- the materials that I had reference to were the Staff's notification of the Applicant, including the analysis of -- I believe it's the Rowsome Studies.

My recollection is that we did receive those materials around the 20th of February, but I could be in error in that respect. Regardless of that fact, you did

receive them approximately three to four weeks ago.

And what I stated was that at the time we received the materials, they were -- they caused substantial concern to the Joint Intervenors, so much so that we contemplated filing a motion before the Board to introduce this matter.

Nevertheless, we did not take such action, and ultimately any intentions that we might have had in that regard were subsumed by the Board's sua sponte motion and order.

MR. TURK: I stand corrected. Apparently, Mr. Jones is referring to a communication from the technical staff to LP&L. And I understand that there was such a communication, I believe in late February. I don't have the exact date.

But now I understand what he was referring to.

JUDGE WOLFE: But, in any event, there are no objections by the other parties to granting the Joint Intervenors to April 12th, within which to file their response to Applicant's motion for reconsideration; is that correct?

MR. TURK: That's correct for the Staff.

JUDGE WOLFE: And I take it that's correct for Applicant.

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All right. Upon the understanding that on -- or by or on April 7th, that the Staff by express mail will file its response in support of Applicant's motion for reconsideration of the Board's memorandum and order raising sua sponte issue -- and will serve that by express mail on April 7th, and there being no opposition, we grant Joint Intervenors' request to file their response to Applicant's motion for reconsideration by April 12th.

Your response also, Mr. Jones, must be by express mail.

MR. JONES: That's understood.

JUDGE WOLFE: -- to the Board and parties.

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MR. TURK: And do I understand that the Licensing Board is aware that if I cannot obtain a written filing by the close of business on April 7th, that I will be entitled to call the parties and Licensing Board to advise them of that fact, and perhaps we'll be able to have a short extension of our time.

JUDGE WOLFE: The parties indicate no problem with that procedure. All right.

MR. TURK: Thank you.

(Board conference.)

JUDGE WOLFE: The Board --

MR. BLAKE: I have one other preliminary matter, Judge Wolfe.

JUDGE WOLFE: This is on a different point. Let me proceed.

The Board has been conferring and we would advise the parties that on or before April 16th, probably be on April 16th, but on or before April 16th after we have reviewed the Staff's and the Joint Intervenors' responses to Applicant's motion for reconsideration, we will confer and initiate a conference call to the three parties to advise whether we are granting or denying Applicant's motion for reconsideration.

I won't tell the parties how to handle their business. You are professionals.

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I have no idea what the responses are going to be. I don't know whether we'll rule up or down on Applicant's motion for reconsideration, but I would suggest that any party that intends to file written direct testimony by the due date of April 20th had best proceed with their preparations.

It will be wasted effort, obviously, if we grant Applicant's motion for reconsideration, but in any event, the due date is April 20th. I don't think anything further has to be said on that.

All right, Mr. Blake, something more?

MR. BLAKE: Only to alert the Board that I have advised and spoken with Counsel regarding the schedule for tomorrow, and it is not our intention now to put on any oral rebuttal tomorrow.

When we finish with Dr. Campbell, I think we will have finished for this week. It's my intention and I have sensed no opposition from the other parties and would hope that the Board would concur in that as well.

Any rebuttal we do, either in oral or in written form, will be done during the next portion of the hearing.

MR. TURK: That is true for the Staff, also.

JUDGE WOLFE: Anything more?

(No response.)

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JUDGE WOLFE: Perhaps we could get some idea from the parties, perhaps now is as good a time as any, what do the parties anticipate will be the length of the hearing tomorrow on Dr. Campbell?

Any feel for that on the cross extent?

MR. BLAKE: I have not reviewed my cross-examination plan since we stipulated to the admissibility of the exhibits, which I think will reduce the time considerably that otherwise I would have had to spend with Dr. Campbell.

I just haven't done that yet, but my guess at this point is two hours.

MR. TURK: I don't think the Staff would have more than two hours. It could even be less.

Of course, we don't know if we'll finish with Dr. Johnson today.

JUDGE WOLFE: Yes. All right. We'll see how we go and take another reading, perhaps, later this afternoon.

All right, Mr. Jones.

MR. JONES: Thank you.

Your Honor, at this time I would like to call the next Joint Intervenor witness, Dr. Carl Johnson.

JUDGE WOLFE: Come forward, please, by the microphone.

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Whereupon,

DR. CARL JOHNSON,

called as a witness by Counsel for the Joint Intervenors, having first been duly sworn by the Chairman, was examined and testified as follows:

JUDGE WOLFE: Be seated.

DIRECT EXAMINATION

BY MR. JONES:

Q. Dr. Johnson, do you have with you a copy of a document entitled, "Sworn Testimony of Dr. Carl Johnson"?

A. Yes.

Q. And was this testimony, Dr. Johnson, prepared at your direction?

A. Yes.

Q. Have there been certain corrections or amendments which you wish to have made to this testimony?

A. Yes.

MR. JONES: Your Honor, if it please the Board, at this time I would like to read the corrections to Dr. Johnson's testimony.

I might point out that these corrections are made in mind of the Board's prior rulings in certain areas in order to alleviate any unnecessary debate concerning certain phraseology which has been somewhat troublesome in the testimony of previous witnesses.

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With the Board's permission I will read the corrections into the record.

JUDGE WOLFE: All right.

MR. JONES: In Question 13 in the third line, the phrase "low-level" is inserted between the words "in" and "radiation."

JUDGE WOLFE: I'm sorry, I don't see. Where are you now?

MR. JONES: Question 13, the third line, between the words -- the fourth word is "in" and the fifth word is "radiation."

Insert between those two words the phrase "low-level." Insert a period after the word "public" and delete the phrase "of 25 to 75 millirems each year."

The sentence then reads in its entirety, "Under NRC operating license specifications, lightwater nuclear powerplants are allowed to release radioactive effluents in amounts which will result in low-level radiation doses to the public."

At the top of the second page of the witness' answer, the phrase "of 25 to 75 millirems per year" is deleted, and substituted therefor is the phrase "from low-level radiation released by Waterford 3."

In the last sentence of the same response, the phrase "around nuclear installations with projected

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exposures of 25 to 75 millirems of radiation per year" is deleted, and substituted therefor is the phrase "based on utility and NRC release estimates."

Proceeding to Question and Answer 21, the word "reasonable" is deleted and substituted therefor is the word "measurable," so that the quotation will read, "There will be no measurable radiological impact on members of the public from routine operation of the station."

On the second line of the answer, the word "reasonable" is deleted. The word "measurable" is substituted therefor.

In Question 22, in the third line, the phrase "in the one-rad range" is deleted, and in the answer on the second line, the phrase "in the one-rad range" is likewise deleted.

BY MR. JONES:

Q. Dr. Johnson, other than the deletions and substitutions which I have just read to the Board, are there any additions, amendments or corrections to your testimony?

A. No.

JUDGE JORDAN: Dr. Johnson, would you be willing to buy a possible correction in your answer to Question 12, which is continued on the top of the next page? Do you see that?

THE WITNESS: Yes, Your Honor.

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JUDGE JORDAN: You have a statement that, "A rad refers to the absorption of 100 ergs of ionizing energy."

Would you be willing to put in there "100 ergs per gram of tissue"?

THE WITNESS: Yes, Your Honor.

The definition, I would say, is one rem of any material, but certainly, here, tissue is appropriate.

JUDGE JORDAN: All right. Whatever words you wish.

So that reads now "100 ergs per gram of material"?

THE WITNESS: Yes, Your Honor.

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BY MR. JONES:

Q. With those amendments and deletions, are there any further additions or corrections to your testimony, Dr. Johnson?

A. No.

Q. Dr. Johnson, I want to ask you if you can identify for us four papers of which -- to which authorship is attributed to yourself.

The first of these is a paper entitled "An Investigation of Brain Cancer, Melanoma and other Neoplasms in Employees of the Rocky Flats Nuclear Weapons Plant in Jefferson County, Colorado." Are you the author of that document, sir?

A. Yes.

Q. Are you likewise the author of a document entitled "Cancer Incidence in an Area Contaminated with Radionuclides Near a Nuclear Installation"?

A. Yes.

Q. And are you the author of a document entitled "Plutonium Hazard in Respirable Dust on the Surface of Soil"?

A. Yes.

Q. And, finally, have you authored a paper entitled "Contamination of Several Public Water Districts with Uranium by Liquid Waste Discharges from an Uranium

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Mine and Development of New Permissible Concentrations Limits for Uranium in Drinking Water"?

A. Yes.

MR. JONES: Your Honor, at this time I would move for the adoption by the Board of Dr. Johnson's pre-filed written testimony as amended this morning.

JUDGE WOLFE: Any objection?

MR. BLAKE: I have no objection to its being incorporated in the record just as though read.

MR. TURK: No objection from the Staff.

MR. JONES: That was my next statement. I was going to move that it also be incorporated as though --

JUDGE WOLFE: I thought that's what you had asked, Mr. Jones. What --

MR. BLAKE: He had asked that it be adopted by the Board --

JUDGE WOLFE: I took that to be -- All right. Without objection, the testimony of Dr. Carl Johnson as amended today will be incorporated into the record as if read.

(The document referred to, the statement of Dr. Carl Johnson, follows:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY & LICENSING BOARD

In the Matter of :

LOUISIANA POWER & LIGHT COMPANY Docket No. 50-382

(Waterford Steam Electric Station
Unit 3)

SWORN TESTIMONY OF DR. CARL JOHNSON

1. By whom are you employed and what position(s) do you hold?

Answer. I am a physician specializing in public health. I hold the position of Associate Clinical Professor of Social and Environmental Health at the University of Colorado College of Medicine. I am a principal investigator on two cancer research projects looking at cancer incidence around a nuclear plant and at the cancer incidence in a population subjected to fallout from nuclear weapons testing. I also do some work in medical consultation.

2. Is this in a specialized health field?

Answer. I am board certified in preventive medicine and public health and licensed to practice medicine in Colorado and several other states.

3. What previous positions have you held?

Answer. I was Director of Health for Jefferson County, Colorado between 1973 and 1981. Prior to that, I was a District Health Officer for the Seattle-King County Health Department and had an appointment as Assistant Clinical Professor in Epidemiology and International Health at the University of Washington School of Public Health in Seattle. Prior to that, at times, I was an acting associate professor at Cornell University, a pathologist with Dupont at their Haskell Laboratory for Toxicology and Industrial Hygiene, and other positions involving research.

4. What are your academic qualifications and degrees?

Answer. I received my M.D. Degree concurrently with a Master of Science Degree in Pharmacology at the Ohio State University College of Medicine in 1965. My pre-medical work led to a Bachelor of Science Degree in 1953 and a doctorate in veterinary medicine in 1955. Since leaving medical school, I studied for a year at the University of California at Berkeley, earning a master's degree in public health. My major interests there were health administration and epidemiology. I have been elected a fellow of the American College of Preventive Medicine and fellow of the American Association for the Advancement of Science. I am currently Chairman of the Program Development Board of the American Public Health Association and ex officio member of the Executive Board, the Action Board and the Governing Council, Co-Chairman of the Joint Policy Committee, and past Chairman of the Health Administration Council. I am a past president of the Colorado Public Health Association.

5. Have you done post-doctoral work? If so, in what field or fields?

Answer. After completing my medical work at Ohio State University, I was recipient of an NIH fellowship from the National Institute of General Medical Sciences to do research on the effects of chronic magnesium deficiency. This led to my master of science degree in 1965. At the University of California at Berkeley, I did post-graduate work for a year, principally in health administration and epidemiology, leading to my master's degree in public health in 1969.

6. Have you done any research in the fields of cancer and/or human exposure to radiation? Please describe your research.

Answer. As Director of Health for Jefferson County, in December of 1974, I was asked by the County Commissioner to do a risk assessment for populations living in the vicinity of the Rocky Flats Nuclear Plant. I did a preliminary assessment of risks, and recommended against permitting people to build their homes around the plant. Following this, I did a survey of surface dust contaminations of plutonium around the plant, with the assistance of two men with the U. S. Geologic Survey. I then published two reports on this work in Science (August, 1976 and May, 1977). Following that, I developed estimates of the risk of cancer to people living downwind from the plant, and this was published in the proceedings of the Fourth International Congress of the International Radiation Protection Association in Paris (April 27-30, 1977). I then did epidemiologic studies of lung cancer death rates and leukemia death rates around the plant and found higher rates. Abstracts of this work were published in proceedings of the American Public Health Association and the American Association for the Advancement of Science. I then did a comprehensive study of cancer incidence in the Denver area related to emissions of the Rocky Flats plant.

The results of this study were published in the proceedings of the Sixth International Congress of Radiation Research, the Fifth International Congress of the International Radiation Protection Association and by the Royal Swedish Academy of Sciences in August, 1981 (reprint of the verbatim in October, 1981 in Colorado Medicine). In 1979, I received a $101,000 grant from the National Cancer Institute to continue these studies. In April of 1981, I was awarded a grant by the National Radiation Research Foundation in Washington to serve as principal investigator in carrying out a study of cancer incidence in people living in southwestern Utah, looking at the effects due to fall-out.

7. What publications have your works appeared in?

Answer. My works have appeared in such journals as Science, The Journal of the American Medical Association, proceedings of national and international scientific congresses and meetings, public health reports, The Journal of Occupational Medicine. The Journal of School Health, and The American Journal of Epidemiology.

8. Do you have any as yet unpublished research data compiled?

Answer. I do at the present time have unpublished research data.

9. Have you participated in any scientific colloquia? If so, under whose sponsorship and what topics have you dealt with?

Answer. I have participated in many scientific colloquia, the last organized myself, a full day's symposium at the annual meeting of the American Association for the Advancement of Science on the subject of "Environmental and Biological Effects of the Nuclear Industry and Nuclear Weapons: Current Status". There were eleven speakers, including one from Heidelberg, Germany and one from Birmingham, England.

10. Have you ever appeared as an expert witness in state, federal or congressional hearings or courts?

Answer. I have served as expert witness in state and federal hearings and courts. I was invited to testify to a Congressional Committee Hearing, but could not attend because of a scheduling conflict.

11. Would you please define the term synergism and indicate how this phenomenon would affect health risks to a population?

Answer. Synergism refers to the action of two or more substances, chemicals or agents to achieve an effect of which each is individually incapable. An example of this effect is the induction of lung cancer in uranium miners and asbestos workers. A report by Lyndon, Archer and Wagner indicates the death rate of lung cancer for men who do not smoke and who do not mine uranium to be 1.7 per 10,000 person years. A non-smoker who is a uranium miner has a risk of 6.5 per 10,000 person years of exposure of dying of lung cancer, or about four times as great. A person who smokes over one pack of cigarettes a day who is a uranium miner has a risk of 51.2 in 10,000 of dying of lung cancer, compared to 1.7 for a person who neither smokes nor is a uranium miner. In the general population, one could expect to see this effect after exposure both to carcinogens in drinking water and to low levels of radiation emitted by a nuclear installation, in the exhaust from its smoke stacks and in its liquid effluents.

12. How are the terms picocuries, rems and rads related to one another?

Answer. A picocurie is a unit of radiation describing an amount of radioactive material releasing 2.2 disintegrations per minute. A rem, or rad equivalent in man, is the effect on the person of one rad of gamma or

beta radiation. A rad refers to the absorption of 100 ergs of ionizing energy. The unit rem includes a factor for biological effectiveness or the ability of radiation to do injury to living tissue. Alpha radiation is much more injurious than is gamma or beta radiation. One rad of alpha radiation yields not one rem, but twenty rems, because the alpha radiation is about twenty times more injurious to tissue inside the body.

The relationship between picocurie and rem is worked out in studies in animals. For example, a group of dogs were allowed by the Atomic Energy Commission to inhale 1,000 picocuries of plutonium. After a period of months, the dogs were killed and the quantity of plutonium determined for the organs in the dogs. 1,000 picocuries of plutonium-239 was found to cause a dose of about 1 rem to lung, 44 rems to the lymph nodes in the chest, about 3 rems to bones, about 1.2 rem to liver, 0.2 rem to kidney, and about 20 millirem to gonads. In addition, there were some exposures to all other organs in the body. Plutonimum does go to all organs in the body when inhaled. Similarly if a person drinks water contaminated with 10 picocuries of uranium per liter, the amount of uranium in the bones will accumulate until the dose finally reaches about 300 millirems per year to bone.

13. Under NRC operating license specifications, light water nuclear power plants are allowed to release radioactive effluents in amounts which will result in radiation doses to the public of 25-75 millirems each year. How does this additional annual radiation exposure relate to the background radiation exposure? At what level of radiation exposure is there a significant increase in cancer rates?

Answer. Dr. Ashekawa in Japan has done studies with a plant called the variant spider wort plant (tratus cancia) which can serve as a monitor for emissions from nuclear power plants. The plant was calibrated in the laboratory with x-rays to determine the number of plant cells which change in color from red to mutant pink. The plants grown around a nuclear power plant in areas where health physicists estimate only doses of a few millirems are found to show doses of over 100 rads inside the plant cells. An EPA surveillance report on the Oyster Creek Nuclear Power Plant in New Jersey found that this facility routinely releases, in the exhaust, 1.2 million curies of radioactive gases and 50 curies of long-lived radioactive particulates, including about 6 curies of neptunium, which becomes plutonium in several days.

A study done of a nuclear power plant in West Germany by the Heidelberg Institute for Environmental Research estimated doses to the public around the plant to be about 1 rem per year. On the basis of their estimate, the West German government refused to build this nuclear plant.

The National Academy of Science Committee on the Biological Effects of Ionizing Radiation estimates that the effect of 170 millirems per year would be an increase of 0.75% in birth defects and diseases related to chromosome injury, which are wholly or partly genetic. In addition, there will be an increase in the amount of ill health due to injury related to chromosome damage, eventually of 5% in the population. Further, there will be an increase of 2% in the spontaneous cancer death rate. Since only about half of cancer cases have a fatal outcome, there will be a 2% increase in the incidence of non-fatal cancers and a similar effect in benign tumors, which are also induced by ionizing radiation. The

NRC license specification

effect on the population of exposures of 25-75 millirems per year would be a fraction of that induced by the 170 millirem dose considered by the BEIR Committee. However, exposures to external radiation will be the least important consideration. Inhalation and ingestion of radioactive gases, vapors and particulates in the air, in the water, or built up in the food chain, i.e. milk, meat, other produce and grains, will be the most important source of exposure to the plant, and these sources of exposure have been very poorly evaluated. A better evaluation of this sort of exposure has been done by the Heidelberg Institute for Research and Environmental and Energy Research. That is to say, it's quite possible that a much higher cancer increase will occur than would be expected around nuclear installations with projected exposures to 25-75 millirems of radiation per year.

14. In studying populations living in proximity to nuclear installations, what health effects have you observed? What is this pattern of cancer characteristic of?

Answer. In my study of cancer incidence around the Rocky Flats nuclear plant, I found an excess of leukemia, lymphoma and myaloma, and cancer of the lungs, thyroid, breast, esophagus, stomach, and colon. This is a pattern similar to that observed in the survivors of Hiroshima and Nagasaki. Cancer of the testes, ovary, liver, pancreas and brain contributed to the excess of all cancer.

15. Are there special segments of the population more likely to demonstrate these health effects?

Answer. The fetus is considered about twenty times more sensitive to radiation than the adult, a child about ten times more sensitive to

radiation than the adult. In addition, people with defects in their immune system are considered to be much more prone to injuries from radiation.

16. Are the health risks associated with radiation cumulative?

Answer. The effects of radiation are considered to be cumulative. That is, one rem over thirty years will have about the same effect as a single exposure to thirty rems. This has been fairly well demonstrated and accepted in many studies of radiation workers.

17. What demonstrated evidence exists of the incidence of non-cancer related diseases in connection with low level radiation?

Answer. Studies of two populations exposed to high background low-level radiation showed increased and dose-related rates of chromosome damage. Studies of plutonium workers and uranium miners also show dose effect changes in chromosome damage. In the population with the higher level of bakcground radiation, there was a four-fold increase in the rate of mental deficiency of the genetic type, chiefly Down's Syndrome. I did a preliminary study on birth defects around Rocky Flats and found the excess of the number was not large enough to be significant in my preliminary study.

18. Explain the health risks associated with external radiation exposure (e.g. fall-out on topsoil) and radiation exposure through air, food and water?

Answer. The health risk associated with exposure to intake of air, food and water are considered to be much more serious and long-lasting than those associated with external radiation exposure, as, for example, from fall-out on topsoil.

19. Given the special geographic circumstances of Louisiana, do you feel there are special risks associated with ground water radionucleide contamination?

Answer. Becuase of the high water table in Louisiana, there are special risks associated in ground water contamination with radionucleides. The experience in South Carolina with contamination of water in Columbia with tridium 100 miles downstream from the nuclear reactors at the Savannah River Plant is an example.

20. What special risks is Louisiana exposed to as a result of high levels of chemical contamination in combination with routine emissions of radiation from Waterford Three?

Answer. We could expect to see a synergistic effect in Louisiana, where people may be exposed to high levels of chemical contamination in the water, along with normal exposure to radionucleids from nuclear plants in the air, water or food. There have been several publications addressed to this general problem area.

21. The NRC staff has concluded, regarding radiation emissions, that "...there will be no reasonable radiological impact on members of the public from routine operation of the station." How does this risk analysis compare with the results of your research in this area?

Answer. I do not agree with the statement by the NRC staff that there would be no reasonable radiological impact from the operation of the station. The NRC Commission is notorious for its industry bias. Members of the Commission in the past have been drawn from the industry or from the nuclear agencies which support the nuclear industry. The NRC is not noted for having any great interest in public health. Their mission is to

serve the industry. The NRC, the DOE and the Office of Radiation Programs of the EPA are the daughters of the defunct Atomic Energy Commission, which achieved great ill repute through its practices of deception and its cavalier attitude toward the public. The arrogant officials, formerly of the AEC, now reside with the NRC, DOE, and the Office of Radiation Programs of the EPA. The only agency to which we can look to for support is the Department of Health and Human Resources, which is the only Federal agency whose primary mission is the protection of public health. We must look to the DHHR with its Center for Disease Control and its National Cancer Institute for some protection.

22. Based on the examples you are familiar with, what is your assessment for the health risk to South Louisiana's population of the introduction of additional radiation in the one rad range resulting from plant operations at the Water Three nuclear generating facility?

Answer. I think that the introduction of additional radiation in South Louisiana in the one rad range resulting from plant operations is unacceptable. Further, I doubt very much that actual exposures will be as small as this, especially when you consider the biological effects of the 240 radionucleides of importance released by nuclear power plants such as that proposed. Many of these radionucleides are isotopes of trace elements and other elements important in nutrition. They will be concentrated and stored in the body in places where they can do much harm. No one has really done an adequate study of the molecular, cellular, and developmental effects of these 240 radionucleides. No one really knows what the long-term effects of these radionucleides on the reproduction of man, animals and plants wil be.

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MR. JONES: Your Honor, at this time I would move for the adoption of the four papers which were identified by Dr. Johnson, those constituting Joint Intervenors' 13, 14, 15 and 16.

JUDGE WOLFE: You have given the necessary copies to the reporter, and they have been marked for identification?

MR. JONES: They will be, Your Honor.

JUDGE WOLFE: All right.

We'll take them individually.

(The documents referred to were marked as Joint Intervenors' Exhibits Nos. 13, 14, 15 and 16 for identification.)

JUDGE WOLFE: Any objection to proposed Joint Intervenors' Exhibit 13?

MR. TURK: The Staff would like to conduct brief voir dire examination on No. 13.

VOIR DIRE

BY MR. TURK:

Q Dr. Johnson, my name is Sherwin Turk. I'm an attorney with the NRC Staff in Washington. If you would, please turn to the document which has been identified previously as Joint Intervenors' proposed Exhibit No. 13.

This is the document entitled "An Investigation of Brain Cancer, Melanoma and other Neoplasms in Employees of the Rocky Flats Nuclear Weapons Plant in Jefferson County."

Do you have a copy of the document in front of you?

A. I have the first page.

Q. Well, you're getting right into my question. The document which I have before me does have a first page which bears the title which I just read.

And attached to it are several pages of what appears to me to be another article, which begins with the title "Contamination of Several Public Water Districts," et cetera.

What is your understanding of the document which you are offering as an exhibit into evidence? Is it a one-page document now?

A. This is the abstract of the report. The full length report is longer, about 10 or 15 pages.

Q. Is it your understanding then that what has been offered into evidence as proposed Joint Intervenors' Exhibit 13 is a one-page document only?

A. What I have is the abstract, which is a cover sheet for the report. It's quite possible I sent only the abstract to the Intervenors. If so, that was an error. I usually send the entire manuscript.

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Q. Is that your recollection, that you only did send the abstract?

A. I don't recall. I can obtain the full copy of the report tomorrow when I return to Denver. I can have it in the mail tomorrow, you should have it by Monday.

Q. Perhaps I might address a question here to Mr. Jones, or perhaps I'm best off at this point just moving -- and maybe Mr. Jones can respond in his answer --

Thank you very much, Dr. Johnson.

MR. TURK: Until this time, the document which has been identified as proposed Exhibit No. 13, and which was received by the Staff along with Dr. Johnson's testimony, consisted of this one-page abstract of the investigation of brain cancer, et cetera, attached to which we found an abstract from the contamination of water district papers, and then the paper itself, with contamination of several public water districts.

We have never seen the article which is abstracted as proposed Exhibit No. 13, the investigation of brain cancer. I have never reviewed it, and I don't know what it is.

The document has not been furnished pursuant to the Licensing Board's order that proposed exhibits be identified and furnished to counsel.

And for that reason, since I only have in front

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of me an abstract of an exhibit, I oppose the admission of proposed Exhibit 13.

MR. JONES: Your Honor, if it please the Board, the abstract of the article, I've double checked, was all that we were furnished by the witness. And that's what we furnished and that's what we propose to introduce as an exhibit.

JUDGE WOLFE: Well, now what -- I'm a little bit confused. I have the abstract, and as pointed out by Mr. Turk, there is an underlying document of some five pages with six pages of reference and attached Figures 1 and 2 -- Tables 1 and 2.

What is that now? Was that intended to be part of --

MR. JONES: That is not intended to be part of the exhibit.

JUDGE WOLFE: I see.

MR. JONES: As I'm sorting out the document, my appreciation is that we were furnished the underlying article, I think in the -- understanding that the article which was furnished was the article which goes with the abstract.

It is not our intention to offer that article as part of the exhibit. And, accordingly, at this time we would make it clear on the record that it is only our

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intention to offer the abstract at this time as Exhibit 13.

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MR. BLAKE: Judge Wolfe, I believe the documents which you have just alluded to will be identified as Joint Intervenors' Exhibit 15.

MR. JONES: That is correct, Your Honor.

JUDGE WOLFE: I see. Do you have anything to say, Mr. Blake?

MR. BLAKE: No.

JUDGE WOLFE: Nothing? All right.

Back to you, Mr. Jones. I understand you are bound by your stipulation.

MR. BLAKE: I must say that my understanding of the stipulation, that all of Joint Intervenors' Exhibit 13 was that it was a one-page abstract. That's the way I understood it.

JUDGE WOLFE: You understood that at the time you stipulated?

MR. BLAKE: I don't know if we ever discussed it, but that's all I had on the subject, and that's what I thought.

MR. JONES: I do believe that Counsel, Your Honor, had had a conference call at some point several weeks ago in which Mr. Blake did raise the question.

I think I recall my answer at the time was that only the page of the abstract, which was all that we had been furnished, constituted the exhibit.

5-2

To the extent that the wrong article was substituted, we do not intend to offer that as a portion of Exhibit 13, essentially inasmuch as it's duplicated as Exhibit 15 in its entirety.

JUDGE WOLFE: Would you point me, Mr. Jones, in the right direction here, precisely at what questions and/or answers in the written testimony of Dr. Johnson there's been an advertence to what is now proposed as Joint Intervenors' 13.

MR. JONES: May I have just a moment, Your Honor, to respond to the question?

JUDGE WOLFE: Yes.

(Discussion off the record.)

MR. JONES: Your Honor, we find at this point in time that we are unable to adequately respond to the Board's question, and accordingly, at this time we would respectfully withdraw the Joint Intervenors' Exhibit 13.

JUDGE WOLFE: All right. Proposed Joint Intervenors' Exhibit 13 is withdrawn.

(The document referred to, previously marked Joint Intervenors' Exhibit No. 13 for identification, was withdrawn.)

JUDGE WOLFE: All right. We'll next proceed to proposed Joint Intervenors' Exhibit 14. Any objection?

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MR. TURK: None.

JUDGE WOLFE: All right. Without objection, Joint Intervenors' Exhibit 14 is admitted into evidence.

(The document referred to, previously marked Joint Intervenors' Exhibit No. 14 for identification, was received in evidence.)

JUDGE WOLFE: With respect to Joint Intervenors' Exhibit 15?

MR. TURK: The Staff has one observation to make with respect to No. 15.

In Mr. Jones' identification of documents a few minutes ago, I believe he inverted the order of Nos. 15 and 16, so that proposed Exhibit No. 15 is the abstract with attached article, entitled, "Contamination of Several Public Water Districts," et cetera.

That's my understanding. I think it was merely a simple error of reading them previously in the wrong order.

MR. BLAKE: At that time he did not identify any of the numbers, but it is true that he inversed the order of 15 and 16, as he identified the documents, Judge.

JUDGE WOLFE: Those will be properly identified to the reporter.

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MR. JONES: Yes, Your Honor.

JUDGE WOLFE: And it's properly marked, identified as being Dr. Johnson's "Contamination of Several Public Water Districts with Uranium Liquid Waste Discharges from an Uranium Mine; and Development of a New Permissible Concentration Limit for Uranium in Drinking Water"; is that correct?

MR. JONES: That is Joint Intervenors' Exhibit 15, Your Honor, that you've just identified.

JUDGE WOLFE: All right.

JUDGE FOREMAN: Mr. Turk, you keep referring to this as an abstract.

MR. TURK: My copy of the proposed exhibit has a cover sheet which bears the title as stated the first line reads, "A Large Uranium Mine," et cetera.

The next page also contains a title, the same title as it appears to me, and begins with a different sentence. So it's my impression --

JUDGE FOREMAN: I understand. You are right.

MR. TURK: That is my impression, but perhaps I am misinterpreting the document.

Mr. Jones could help us out there.

JUDGE WOLFE: In other words, the first page is an abstract.

MR. JONES: That is correct, Your Honor, and

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then the entire article is attached thereto, and both the abstract and the article constitute the exhibit.

JUDGE WOLFE: Any objection to the admissibility of Joint Intervenors' Exhibit 15?

MR. TURK: The Staff has none.

JUDGE WOLFE: All right. Joint Intervenors' Exhibit 15 is admitted.

(The document referred to, previously marked Joint Intervenors' Exhibit No. 15 for identification, was received in evidence.)

JUDGE WOLFE: Any objection to the admissibility of Joint Intervenors' proposed Exhibit 16?

MR. TURK: The Staff has no objection.

JUDGE WOLFE: Without objection, Joint Intervenors' Exhibit 16 is admitted into evidence.

(The document referred to, previously marked Joint Intervenors' Exhibit No. 16 for identification, was received in evidence.)

MR. JONES: Your Honor, at this time I would note for the record that the reporter will be furnished with three copies each of Joint Intervenors' exhibits 14,

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15 and 16, and also thirteen copies of the prefiled testimony of Dr. Johnson.

JUDGE WOLFE: All right.

Mr. Jones.

MR. JONES: I have nothing further at this time, Your Honor.

JUDGE WOLFE: We will proceed to cross-examine. Mr. Blake.

CROSS-EXAMINATION

BY MR. BLAKE:

Q. Dr. Johnson, my name is Ernest Blake, and I represent the Applicant, Louisiana Power & Light in this proceeding.

Dr. Johnson, have you ever visited the Waterford 3 facility?

A. No.

Q. Have you ever read the Final Safety Analysis Report written by the Applicant in this proceeding which describes the plant?

A. I've reviewed that, yes.

Q. You've reviewed the Final Safety Analysis Report? Do you recall when that was?

A. Well, I had some documents prior to coming and I reviewed some after arriving yesterday.

Q. There may be confusion here. Hold on just for

5-7

a second.

The Final Safety Analysis Report --

A. No, I haven't --

Q. -- developed by the Applicant is a multi-volume --

A. I haven't read it.

Q. -- document?

A. No.

Q. You were confused?

A. Yes.

Q. You haven't looked at that document?

Have you reviewed the Applicant's Environmental Report?

A. Yes. This report.

Q. I see.

MR. BLAKE. The record should reflect that Dr. Johnson has held up the Staff's Final Environmental Statement.

BY MR. BLAKE:

Q. The Applicant's Environmental Report again is a document that is included in volumes so that they look like this.

Have you ever seen any document that looks like this?

A. The principal document I reviewed was the

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Final Environmental Impact Statement.

Q. Have you ever reviewed a document that looks like this --

A. No.

Q. -- the Applicant's Environmental Report?

A. No.

Q. Have you reviewed or read the NRC Staff's Safety Evaluation Report on Waterford 3 or its supplements?

A. No, I haven't seen them.

Q. You've indicated that you have read through the NRC Staff's Final Environmental Statement, the yellow book that you have in front of you?

A. Yes, I have. Yes.

Q. Would you say you are familiar with that document now?

A. Well, I've reviewed it. I've reviewed many others like it.

I think to refer to phrases and figures I would need to refer to it again, if that's what you mean by being familiar.

Q. When did you first look at that document?

A. I saw some excerpts from it some weeks ago. I saw the full document yesterday.

Q. Do you have with you those excerpts you are referring to?

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A. I have some in my briefcase.

Q. Even without referring to them, could you identify what excerpts you are talking about?

A. These had to do with tables describing emissions, projected emissions.

Q. Emissions, did you say?

A. Releases of radioactivity.

Q. Was that prior to the time that you wrote your testimony?

A. This was -- well, some information came prior to that, yes.

Q. Some excerpts from the Final Environmental Statement you read prior to the time you wrote your testimony?

A. Well, it could have been from the preliminary draft. I can't say. I didn't have the whole document.

Q. But prior to developing and writing your testimony, you reviewed some excerpts from that document, or was it after? That's really what I'm trying to determine.

A. No, I had some information prior to it.

Q. Some excerpts from the Final Environmental Statement?

A. Excerpts from this draft or an earlier draft.

Q. From the Final Environmental Statement or from

5-10

an earlier draft of the Final Environmental Statement?

A. Yes.

Q. Are you then familiar with the source terms that the NRC has used for its emissions from the Waterford -- anticipated emissions from the Waterford 3 plant?

A. Could you define that further?

Q. Could I define "emissions"?

A. "Source terms."

Q. By "source terms" --

A. I don't recall the specific source terms, no.

Q. You don't recall any, but you have reviewed that portion of the document in which they are identified.

By "source terms," I really mean the emissions by and large by isotope.

A. That identifies them better, yes. Yes, I saw some of those.

Q. And are you familiar with the Chi over Q values which the NRC Staff has used?

A. Relative to --

Q. Relative to evaluating what might be the expected doses due to the emissions from Waterford 3?

A. Oh, doses, yes. I'm a physician basically. I'm not a nuclear physicist, or....

My interest is dose estimates, and I have reviewed dose estimates for this reactor and for many

5-11

others, and I am convinced that it's really not much more than numerology, because there are so many assumptions on which those are based.

The assumptions have become very controversial, and I don't think they are acceptable.

Q. Would you define for me Chi over Q?

A. As I said, I'm a physician.

Q. I see. Are you familiar with the term "Chi over Q"?

A. No, I would not use that term medically.

Q. Is there some term that you would use to describe the dispersion factors which are used in estimating doses from a source such as the Waterford 3 facility?

A. My approach would be to take measurements in the soil from existing nuclear plants and see what's present, or in plants and animals indigenous to the area, as was done around the Savannah River reactors.

Q. Dr. Johnson, have you ever taken any measurements around a nuclear powerplant, such as the Waterford 3 facility?

A. I've taken measurements around a nuclear plant in my health district.

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BY MR. BLAKE:

Q. Is that nuclear plant, as you refer to it, the Rocky Flats?

A. That's correct.

Q. -- plant?

Have you ever taken any around an operating commercial nuclear power reactor, like Waterford 3?

A. No.

Q. Do you know what type of reactor it is?

A. It's a pressurized water reactor.

Q. But you don't claim any expertise in nuclear engineering, I take it?

A. That's correct.

Q. Are you familiar with 10 CFR Part 50 of the Commission's regulations?

A. Pardon?

Q. Are you familiar with 10 CFR Part 50, particularly Appendix I, of the Commission's regulations -- the NRC --

A. No. No, I'm not.

Q. Have you ever done any dose calculations based on emissions from a nuclear power plant like Waterford 3?

A. I believe some other witness for the Intervenors will testify for these areas.

Q. Have you ever done any?

A. Dose calculations?

Q. Yes, sir.

A. No, I haven't.

Q. I take it since you've never done any, you would not consider yourself to be expert in these calculations?

A. Not in the calculations as such, no.

Q. Do you have any reason to quarrel with the NRC's calculations as they have done them?

A. Yes.

Q. I see.

And your basis for that is what?

A. Publications by the Heidelberg Institute for Energy and Environmental Research, the NRC has translated some of their work, I believe.

This group in Heidelberg criticizes assumptions made on the basis of uptake by plants grown in soil which are sterilized to kill soil bacteria.

Q. I'm familiar with Heidelberg. Are there other factors which provide the basis for your quarreling with the NRC's estimates?

A. Another area is the uptake of radionuclides released from nuclear power plants, which have been converted to organic form by soil bacteria, rumen bacteria.

6-3

Radiocobalt, for example, in milk is mostly in the form of radioactive $B_{12}$, which has an uptake by lever three orders of magnitude greater than for inorganic radiocobalt.

Q. What factors --

A. -- and goes directly into cellular metabolism.

Q. What uptake factor does the NRC use in their calculations?

A. I don't recall what it is now.

Q. Why would you quarrel with it if you don't know what it is?

A. I understood that it was much less than that represented by the uptake of radiocobalt incorporated into $B_{12}$.

Q. And where did you come by that understanding?

A. The Heidelberg Report.

Q. I see.

So we're back to the Heidelberg Report --

A. Yes.

Q. -- as being a basis.

Are there any other bases that you have?

A. Well, I'm familiar with the problem at the Oyster Creek Nuclear Power Plant, which I think has surveillance under supervision of the Nuclear Regulatory

Commission.

And an EPA report describes the release of 1.2 million curies of radioactive gases routinely into the exhaust each year and 50 curies along of radioactive particulates, including 6.8 curies of neptunium.

And I described this report to a health physicist retained by the Board of Supervisors of the county. And he had been appraised by the NRC that this plant did not release anything radioactive of consequence.

And he hadn't heard of the EPA report, which I had to xerox and send them, because he couldn't obtain it from the EPA either.

This is one example of the sort of problem with the NRC; that is, in my experience with the NRC. There doesn't seem to be very good information about such releases.

Another problem --

Q Excuse me. But let me stick -- Are you going to go away from the Oyster Creek problem? Let me stick with that?

A Yes, I am. I'm going away from Oyster Creek.

Q Let me stick with that just for a moment. I think you started out by saying you're familiar with the Oyster Creek --

6-5

A. -- surveillance report.

Q. Surveillance Report.

Have you ever been to Oyster Creek or done any evaluations yourself of the Oyster Creek facility?

A. No. The EPA did a very expensive, long-term evaluation.

Q. So your --

A. So I didn't feel the need.

Q. -- basis is the EPA's report on Oyster Creek's releases?

A. Yes.

Q. I'm sorry. Now if you'd continue. You had other factors?

A. Yes. The EPA report on Oyster Creek described their release of -- as I said -- large amounts of neptunium 239, which is the parent for plutonium.

The NRC sent me data on releases of neptunium by other types of plants, two -- I think two other boiling water reactors and three pressurized water reactors, which describe also releases of neptunium, but five orders of magnitude smaller.

And I was very impressed at the difference. The EPA would find releases of neptunium five orders of magnitude greater than those for five other nuclear plants.

6-6

Q. I see --

A. It surprised the NRC.

Q. So this is still the Oyster Creek EPA study?

A. Yes.

Q. I see.

Are there others?

A. Yes.

Q. Okay.

A. Nuclear plant workers had a chromosome study which found that the workers at a dose -- body burden of plutonium of one to ten percent of levels permitted by existing regulations, had a 33 percent increase in chromosome aberrations and circulating nymphocytes.

I filed a formal protest with OSHA -- Dr. Eula Bingham -- and found that OSHA is not able to investigate this health effect on workers. And so I then began to question the role of the NRC in this area, why can't they take action to investigate an obviously grossly inadequate standard.

Q. All right. Have you looked at NRC reports or evaluations of that subject?

A. Well, there was a response from the plant, which said that in conferring with appropriate officials, they concluded there was no problem with these chromosome aberrations.

6-7

Q. Let me say it again: Have you read or evaluated any NRC reports of this problem?

A. No. And as far as I know, there are none.

Q. The NRC has never looked at this question?

A. I can't speak for the NRC. I've never seen any NRC publications that address this problem.

Q. Any others, Dr. Johnson?

A. Yes. In regard to evaluation of off-site contamination around Three Mile Island, I pointed out the need for a survey of surface dust to look for plutonium and other actinide levels released by the plant. There was such a large volume of radionuclides released from the core -- there should have been actinides released as well.

I received no response to my letter to the NRC. Later, about six months later, I asked a Commissioner at a meeting of AAAS why there had been no survey done off-site.

He said that some work would be done, and we'd get a response.

Well, about six months later I had a one-page report describing a survey at seven locations around Three Mile Island with samples to a depth of 15 inches.

And, obviously, if you're looking for surface contamination of a plant, you don't take a sample 15 inches

deep.

This seemed to me to be a devious way to do a survey.

Q. Have you evaluated the various reports on releases from Three Mile Island, which include the Presidential Commission's report and the Goldman study, Congressional reports on that subject, those done by the licensee in that case and the NRC, EPA and DOE?

A. Well, those reports are very voluminous. I reviewed a few reports. I'm aware that no one really knows what was released in the first three or four hours after the accident.

But a study of people living near the plant found levels of radioiodine which would be consistent with a dose rate of about six rems per year.

No one appears to know the total dose. But a dose of six rem to the thyroid is not consistent with dose estimates of one millirem -- total dose --

Q. Which study of people are you referring to?

A. This is the one -- I think the senior author was Fields, et al. Fields and some other authors.

I have the reference, if you want that. I don't have it here with me.

But I have it here. It's in my briefcase.

It's in a report by Dr. Morgan given at the

last meeting of the American Association of the Advancement of Science.

Q. Dr. K. Z. Morgan?

A. Yes. He has serious concerns about nuclear power plants in general and the assessment of the release at Three Mile Island in particular.

Q. And you said that you had reviewed some of the reports -- or portions of some of the reports, but they were so voluminous that you're not certain --

A. They're very voluminous. It would take a staff of pepople to review all those reports.

But I'm certain that the summary information reflects, in my opinion, an underestimation of releases. I would agree with Dr. Morgan, in other wcrds.

Q. Have you yourself looked at or done any evaluations of the Three Mile Island area, or the resultant releases?

A. I visited the area two weeks after the accident. I was invited by the Pennsylvania State Medical Society and the faculty at the medical school in Pittsburgh to give a talk on radiation effects.

And at that time I looked at the early information, which at that time was not so voluminous.

Q. So that's the extent of your knowledge or -- that is, personal involvement of --

A. No. Following that I had correspondence and received reports of various types.

Q. These are the voluminous reports that you earlier referred to?

A. No, no.

Q. Other reports?

A. Summary reports, summary information.

I also had contact with the EPA radiation officer for Region VIII, who from time to time would give me some key information about the investigation, including the early measurements of plumes from the plant, which indicated a very radioactive plume from the plant.

Q. Any more?

A. That's all I can recall.

Q. In your answer to Question No. 1 on the first page of your prepared testimony, in the fifth line you refer to "around a nuclear power plant." Is that the Rocky Flats plant?

Are you referring there to the Rocky Flats plant?

A. Which question?

Q. Your answer to Question No. 1, in the fifth line.

A. No. This is the -- It's a plutonium and uranium reprocessing and nuclear waste disposal operation,

6-11

Rocky Flats plant. Like a nuclear power plant, they handle ton quantities of uranium, and they have large amounts of plutonium, as do all operating nuclear plants.

Q. Does it appear -- Do the quantities of plutonium and uranium to which you refer appear in the same configuration at this plant that you refer to in your testimony as they do at a commercial nuclear power plant?

A. Plutonium in a commercial nuclear power plant would be in the reactor core or in fuel rods removed from the core, on the order of -- oh, some hundreds of pounds or more -- after several years of operation.

In this plant, they would be stored in a large storage area in an inert atmosphere after being reprocessed, and they're milled in lathed boxes.

At both plants they use the same sorts of filters. The high-efficiency particulate air filters, except this plant has five and six filters in a series and --

Q. I'm sorry, "this plant" being --

A. -- most plants have only two.

Q. "This plant" -- I'm just confused as to what plant you're referring to.

A. This plant, the Rocky Flats plant, described in answer to Question 1.

Q. It is the Rocky Flats plant which you're referring to in that answer?

A. That's correct.

7-1 ge

Q. Is it your opinion that there will be uranium releases from the Waterford 3 plant during routine operation?

A. I would think so.

Q. Did you say would or would not?

A. Would, yes.

Q. You would?

A. I would think so, yes.

Q. What would be your opinion as to the source, pathway and amount of such releases?

A. I asked this question of an NRC Commissioner --

Q. Who was that?

A. I don't recall his name, but he gave a talk in San Francisco after the TMI-2 accident, and he said he would send some reports.

He did, finally, but they described only the releases of uranium, neptunium, plutonium, curium, et cetera, into liquid discharges from live plants.

I never got any reports from the exhaust plumes.

However, I did ask a radiation official of the EPA why for Oyster Creek, they report neptunium releases, but none for plutonium, and he said, "This wouldn't be self-serving, would it?"

Q. What is your estimate of the --

A. These things --

7-2

Q -- source, pathway and amount of uranium releases from Waterford 3?

A Pardon?

Q What is your estimate of the source, the pathway and the amount of uranium which you anticipate will be released from Waterford 3?

A Well, if you look at older plants, the releases would come from the point where the uranium fissions, uranium and plutonium fission to create some 1800 different radioisotopes, many of the gaseous.

At the very high temperature and pressure at the point of fission, I imagine they are all gaseous.

These releases cause pressure to build up within fuel rods.

The fission products and activation products escape through pinhole openings and cracks which develop in the cladding. They escape through the coolant, through bushings, through cracked pipes, if they crack; and this is why at the Oyster Creek plant you have 1.2 million curies of gases, and 50 curies of particulates which escape from the core, from within the cladding.

You have this very large amount coming off routinely in the exhaust plumes from the plant.

The EPA indicates a number of other plants have such releases as well, and every report I've seen of

7-3

any plant indicates they have measurable releases of radionuclides.

Q. You've referred to fission product, gases which are created within the fuel rods, the nuclear powerplant.

Is it your opinion that uranium would be such a fission product, gas?

A. Oh, no, not uranium. There would be some uranium that could escape, certainly, but not the -- you can have -- there are some uranium isotopes created by activation. Activation of thorium; Uranium-233, you've heard of that; 234; and 235, of course, you need for neutron flux to begin with; 236 and 237; and there's a lot of 238. That's your principal constituent in most reactors.

Q. All right. What I'm asking you, Dr. Johnson, is source of the uranium which you think will result in effluence from the Waterford 3 plant?

A. The uranium in the core.

Q. The uranium in the core will do what?

A. The source, this is the source of the uranium.

Q. Describe to me how it will be released.

A. Through pinhole openings, cracks in the cladding.

Q. As a gas?

A. Well, only where you have fission occurring

7-4

it can be in a gaseous form, but, of course, would condense immediately once it's cooled.

Q. The uranium from the fissioning process is a gas, but would condense as soon as it cools?

A. At very high temperatures it's a gas, but would cool and form very fine particles.

Q. Is it your testimony that the uranium would escape from the fuel rods as a gas?

A. No, no.

Q. No. Would you describe it to me again, because I don't understand what mechanism it is that you are describing which would result in a source term of uranium.

A. Well, you would have bubbles, I would imagine, radioactive gases. Within the bubbles, you would have very fine particles of solids now being cooled.

This is how you can have releases of neptunium and plutonium and other actinides.

Q. Are you aware of any document -- you have said you are not a nuclear engineer, but that you are a medical doctor.

Are you aware of any document which would support your thesis?

A. Well, I did ask, as I said, one of the Commissioners of NRC for a report of some of those

7-5

measurements, and he said that he would send them to me, but I haven't received them yet.

Q. Are you aware of any documents by nuclear engineers or whatever class you would describe as people who would understand the reaction in the fuel of the reactor that would support your thesis that uranium comes out as particles within gaseous bubbles?

A. No. You just said how do I think. The NRC doesn't describe that, but I do have NRC reports which describe the release from five nuclear plants of uranium, plutonium, curium and so forth, the actinides.

I have those. I don't have them with me, but I can have them in the mail.

Q. You have reports which speak of uranium releases from plants like Waterford 3?

A. Well, of course, Waterford 3 isn't in operation yet.

Q. Right.

A. But in the April issue of "Health Physics Journal" you'll find a list of 240 radionuclides of importance released routinely by nuclear powerplants.

This list includes uranium, and they are talking about gaseous releases as well, April "Health Physics Journal," 1980.

That's the reference I should have given you

7-6

earlier. I didn't think of that.

Q. Is that the source of your information, or would that be the basis for your saying that uranium would be included in the releases from Waterford 3?

A. No. I thought it very likely such releases occurred before then on the basis of the very large volume of radioactive gases and particulates released of other types.

These all come from the core and if they can come from the core, then the actinides can come from the core, also.

The evidence that Neptunium-239 is present further indicates that you can expect those to be present.

The radiation control officer for Region VIII in the EPA appeared to confirm this when he said it wouldn't be self-serving to report this, that these actinides are released in routine releases.

Q. So this is a theory that you have that you would suspect that that might be the case, but you have nothing to substantiate it?

A. No, I thought it was --

Q. You have something to substantiate it?

A. -- confirmed by the "Health Physics" article.

Q. Did the "Health Physics" article that you recall describe the source?

7-7

A. No, but the Heidelburg Report does list the various means by which the contents of the fuel rods can be released.

They have diagrams and they explain just how it occurs. The NRC has that, since they've translated it.

Q. So the basis is the Heidelburg Report?

A. I'm sure there are many such reports. Heidelburg is one of them.

Q. Let me assume, Dr. Johnson, that you are correct, that uranium particles get captured in gas bubbles which escape from the fuel rod.

What is the --

A. But that's not a fact. You asked for my opinion as to how it might occur.

Q. I understand you are not an expert --

A. I'm not saying I'm correct or not.

Q. -- in this area. You don't profess to be. You really don't know whether that's right or not.

A. But you are saying how could it happen. I just know it comes out the stacks of Oyster Creek. Neptunium comes out and I assume that the others come out as well.

These conclude a series of isotopes. Uranium is not one, but it's a number, as you know.

They are listed in the "Health Physics Journal"

7-8

article.

Q. Have you seen reports that uranium actually comes out of Oyster Creek or any other plant, other than the "Health Physics Journal," which says there are a number of isotopes that either can be released or may be released from nuclear powerplants, and here is a list of them?

A. The NRC reports which were sent me, I believe, list uranium coming out of five plants. I may have that in my briefcase, that table.

Q. Maybe you could check on that during the break and let me know.

A. Yes, I'd be glad to give you a copy of that.

Q. Okay.

You have referred now on several occasions to plutonium and to neptunium as possible releases.

A. Pardon?

Q. You have now referred on several occasions to neptunium and to plutonium as potential releases.

A. Yes.

Q. Is it your opinion that plutonium will be released from the Waterford 3 plant during routine operations?

A. It's my opinion that it would be, yes.

Q. That plutonium would be?

7-9

A. Yes.

Q. Plutonium as its precursor, neptunium, or plutonium?

A. You would certainly find much more neptunium than plutonium, because there's much more plutonium in the core; but I maintain that if neptunium is escaping from the core into exhaust plume, as it certainly will, you will also find small amounts of plutonium as well.

Q. Is it your opinion that the neptunium which is emitted from Waterford 3 will be as a gaseous release?

A. Well, mercury is a very heavy solid metal that forms a vapor which is a gas.

If you take a metal like plutonium or another alpha emitter, it will divide and divide because of the alpha recoil effect until you have single atoms of plutnoium.

Now, suspension of single atoms of any solid material, steel or whatever, is in effect very similar to a gas, behaves like a gas.

Around Rocky Flats plant, for example, to describe behavior of plutonium, studies there show that almost all plutonium offsite is on the order of single atoms or groups of atoms or particles too small to measure because of alpha recoil effect.

So I think that you can say that it's not a

7-10

gas, but still if it's divided until it's in particles of single atoms or groups of atoms, you've got essentially a gas that will pass through filters .

An article in "Health Physics Journal" describes this in 1977, the alpha recoil effect, and describes how plutonium and similar alpha radiation emitters may pass through four or five absolute filters or high-efficiency particulate air filters.

That's how it could happen.

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BY MR. BLAKE:

Q Dr. Johnson, do you expect it to come out among the gaseous releases from the plant or in the liquid effluent from the plant?

A Both.

Q What is the pathway that you can describe, if you can, for the gaseous releases of neptunium?

A Well, I would imagine that it would be released along as a gas, as a very fine particle.

And there are several points in the -- well, I would refer you to the Heidelberg report, in which it summarizes the various points of release pretty well.

There is a build-up of pressure inside the fuel rods, inside the various loops and circuits of the power plant, because they're converting a very heavy metal into a large amount of radioactive gas and fine particulates, when you fission uranium or plutonium.

Q Where does the neptunium come from?

A It's an activation product. The -- Uranium 238 is not readily fissioned itself. Uranium 235 is fissioned readily.

The neutrons created by that, you can convert uranium 238 to neptunium 239, which becomes plutonium, which is also fissionable.

That's my understanding of it. But as I said,

8-2

I'm not a nuclear engineer. That part is pretty simple; that is, the basic operation can be understood.

Q. Is it fair to say that your -- to recapitulate with respect to uranium and to plutonumium and the possibility of their releases from Waterford 3, you have not reviewed the design of the Waterford 3 facility; correct?

A. That's correct.

Q. You are not a nuclear engineer --

A. No.

Q. -- nor do you propose to be an expert in this area?

A. That's correct.

Q. But that you would suspect that uranium and plutonium or -- at least its precursor, neptunium, would be released from the Waterford 3 facility, and that the basis for that is the Heidelberg study, the report which you've reviewed?

A. And the "Health Physics Journal" and NRC documents sent to me which describe these releases at five plants, including three pressurized nuclear power plants.

Q. Which you're going to review during the break or give me a copy of during the break.

A. I have a summary table taken from those documents.

8-3

Q. But that you were not able to describe what the pathways might be which would -- which these elements would take; you yourself can't describe to me how they're going to get out. You just -- They're going to, because these reports have said they're going to. Is that a fair --

A. They've been well described by -- you know, by others, and I would rather refer you to those documents.

Q. And that's the documents that you've identified to me: the Heidelberg Report, the "Health Physics Journal" of April 1980 and some NRC reports, or at least one report --

A. Yes. There is ample evidence of actual releases from all nuclear plants. That is, all that I have seen describe such releases.

Q. What is the amount of the release?

A. At the Oyster Creek plant, 1.2 million curies of radioactive gases are released, and about 50 curies along of particulates.

Q. Other than the Oyster Creek plant, those figures having been set out in your testimony --

A. -- and 6.8 curies of neptunium 239.

Q. That's also in your testimony. I think it says six in your testimony, but I would agree with you that I think the data report says 6.8.

8-4

A. 6.8, that's correct.

Q. Do you have some estimate for Waterford 3? What's your estimate of how much either uranium or neptunium which is going to become plutonium would be released?

A. I really don't give any credence to estimates, because estimates in the area of health physics and nuclear power plants keep falling down. They don't really hold up.

So I would say: Look at the operating experience with existing plants. And this is probably what you'll find with a new plant coming on line.

Q. Are you aware that -- Are you aware of any plant similar to Waterford 3, which has had releases of either uranium or plutonium which exceeded that plant's expected releases of those isotopes?

A. You're referring to pressurized plants?

Q. Plants similar to Waterford 3, yes -- light water commercial nuclear power plants.

A. The NRC documents didn't give the projected releases. They simply have reported their releases of plutonium and neptunium and the other actinides.

Q. Are you aware from any other source of any plant similar to Waterford 3, which has actually released either uranium or neptunium, which is going to become

8-5

plutonium, in amounts greater than what was calculated and expected during routine operations?

A. Ycu see, this is a question with no answer, because I'm looking at his reports for other plants, I haven't seen projected releases for the actinides.

Q. Is it fair to say then that you have no evidence that that's the case?

A. No evidence?

Q. Do you have any basis for guessing at this point that the actual releases of those elements have been greater than what has been expected to be released?

A. I can't -- You see, when you don't know what has been expected -- when it hasn't been published, you can't say what was in the mind of the person who wrote the document.

Q. Is it because it hasn't been published, or because you just haven't looked at the reports?

A. I have looked at some reports, not for this reactor, but I didn't see projected -- projections for releases of actinides. They simply weren't mentioned.

Q. Are you aware of whether or not there are any anticipated or expected or projected releases from Waterford 3, which would include neptunium?

A. Yes. I understand that there is a figure of three millicuries per year, which was amended by an

order of three orders of magnitude.

Q. I don't understand the smile. Can you explain that to me?

A. Well, I would think that if you're designing a nuclear reactor, that to make an estimate which later must be corrected by three orders of magnitude, implies some problems.

Q. Is it your understanding that was a correction, a goof that had to be corrected?

A. It was a correction.

Q. And where do you come by your understanding of the nature and basis of that correction?

A. All I'm aware of is that it's a correction.

Q. Could it have been a typographical error, as far as you know, in the publication?

A. Not for a column of figures, scarcely.

Q. It could not have been a typographical error, in your opinion?

A. I don't know.

Q. Do you know that the NRC stated that the reason that they had to change the figure as appeared in that table was merely because it was a typographical error?

A. I have no access to correspondence.

Q. What is your knowledge about that change?

A. I'm aware that it was a correction.

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That's the extent of my knowledge.

Q. Do you have any reason to believe that the NRC's explanation for that change might be something -- any reason to believe that the NRC's explanation that it was a typographical error might be incorrect?

A. As I said, the extent of my knowledge about the correction of the row of figures by about three orders of magnitude is that it is a correction. I don't know any more about the incident than that.

MR. BLAKE: Can we take a break?

JUDGE WOLFE: We'll recess until five minutes after 11:00.

(A short recess was taken.)

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JUDGE WOLFE: During the recess -- if I may break into cross-examination -- I wanted to bring it to your attention at the earliest possible time, I have checked my calendar, and I will be at a hearing in Houston April 12 through April 16; and I will be unavailable for that conference call.

The Board members discussed this, and we thought we'd discuss this with the parties. They can do one of two things: We -- the Board members are always in contact, and particularly when there's an outstanding matter to be resolved or what have you.

Obviously, the Board members will be in telephonic contact with one another before April 12 and thereafter.

What we can do, inasmuch as I will be out in the field or riding circuit, or whatever you want to call it -- what we can do is initiate a conference call and I would delegate Judge Jordan to speak on my behalf, so we would have already made some sort of ruling and decision in our discussions during the week of April 12 through 16 -- made up our minds on how to rule on Applicant's motion for reconsideration.

Judge Jordan would then be in on the conference call, in my absence, and along -- with Judge Foreman in on the conference call could make a ruling that all

members, hopefully, will have agreed upon. And he will act in my behalf in so ruling.

If that's agreeable to the parties, we'll proceed that way. If not, I will be back in the Bethesda/Washington area at my office on April 19th and can rule at that time in a conference call. If the parties want to discuss it between themselves, do so in the next several minutes and let me know which option -- which alternative is agreeable to everyone.

We'll go off the record now, and you can discuss it amongst yourselves.

(Discussion off the record.)

JUDGE WOLFE: Back on the record.

MR. BLAKE: Judge Wolfe, the parties have conferred. There is general agreement that as early notice as we can get of the Board's determination in this respect is really what we're after, be it by notice from Dr. Jordan of the Board's ruling or yours or, in fact, the Board's secretary.

What we want to know is what the Board's ruling is.

JUDGE WOLFE: Yes. Up or down on your motion for reconsideration.

MR. BLAKE: That's really what we'd like.

JUDGE WOLFE: Well, perhaps then we can just

handle it --

JUDGE JORDAN: That's what I will do then.

Dr. Foreman and -- We will have discussed it between us and the Chairman on Friday morning. I will ask the Chairman's secretary to call all of the parties. It's just a matter, as you say, of going up or down; and I'd prefer to do it that way.

MR. BLAKE: To the extent ...

JUDGE JORDAN: If the parties have any problem, then call me Friday morning, with the -- well, I guess I can't -- if you have any questions or something like that.

But I think -- I don't see how there can be.

MR. BLAKE: To the extent we have procedural problems or what not, those, I think, will just have to wait until Monday when the Chairman gets back.

JUDGE JORDAN: That's right. If you have any procedural problems, wait until Monday to get the Chairman.

MR. BLAKE: The other thing that this news brings, Judge Wolfe, to each of us is the question of where is it that you'd like pleadings sent, which are not to be filed until the 12tn.

Can we still use just your office? Is that as

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good as we can do, or can we do better by you? To the extent that we can do better by you, would you just let us know -- maybe after the lunch break or what not.

JUDGE WOLFE: All right. I'll do that.

I don't know the address of the Howard Johnson Hotel on -- it's either Katy Road or Katy Freeway in Houston. But that would be where you would be sending your submission, Mr. Jones. Obviously, I will receive Staff's submission in Bethesda on or by -- what? April 7th or 8th. There's no problem there. It's only Mr. Jones.

So if you will -- I will try to find out that Howard Johnson address. You can send me by express mail your submission.

MR. JONES: Surely.

I believe that the designation of the thoroughfare is Katy Freeway.

JUDGE WOLFE: Katy Freeway.

All right. Fine.

Something was handed to us, Mr. Jones --

MR. JONES: Yes, Your Honor, if I might identify this document. Your Honors will remember that Dr. Johnson was being questioned with respect to his appreciation for releases of radionuclides.

The Applicant's counsel had requested that he provide a reference, and he has done so over the break.

I simply wanted to make a copy of this available to Your Honors, in the event that there are any further questions relative to this information. This is not at this time being offered as an exhibit, but merely as an assist and aid in the understanding of the witness' testimony.

JUDGE WOLFE: This was extracted from what document, Mr. Jones?

MR. JONES: I believe Dr. Johnson can identify the specific source.

THE WITNESS: This came from a report sent to me by one of the NRC Commissioners. It's a report by Malero, J. C.; Essig, T. H.

The title of the report that this came from: "Doses from Radioactive Actinides Released In Liquid Effluents from Light Water Cooled Nuclear Power Reactors." This didn't copy too well.

But it was a paper presented at the Health Physics Society at Buffalo, New York on July 13, 1975.

BY MR. BLAKE:

Q Dr. Johnson, thank you for that; and I will look at that over the lunch hour, or in fact later on.

Dr. Johnson, do you have any different estimate of what the releases of neptunium will be from Waterford 3 than those provided by the NRC in their Final

Environmental Statement?

A. I would not be able to make an estimate of the volume of such releases, but would expect to see important amounts released, based on reports of releases at other plants, such as the 6.8 curies per year of neptunium 239 at the Oyster Creek plant.

Q. And something else? Or that?

A. Well, and also this document here which implies that there are such releases from pressurized water reactors, and further that there may be large differences in quantities reported by different federal agencies.

Q. It is the table that you've just referred to, the one which is entitled "Calculated Releases"?

A. That's correct.

Q. And this would give you a different --

A. No. I would use something like this and the EPA report to make opinions about the quantity of such releases.

I haven't made an estimate of releases for this plant here.

Q. Do you think your background or training would enable you to make such an estimate?

A. I would rely on experts, like the people at Heidelberg that I referred to earlier.

Q. Referring to your -- Just to summarize, you

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have no estimates other than those by the NRC, but you suspect that they would be different, based, one, on the EPA study at Oyster Creek; and, two, on your understanding of the Heidelberg Report?

A. Could you repeat the question?

Q. I'm sorry.

You have no estimate of what the releases might be from Waterford 3 of either uranium --

A. No. I have calculated no estimate.

Q. -- of either uranium or plutonium.

But you suspect that they may be different from the NRC's and the basis for that suspicion is what you do know about Oyster Creek's releases from the EPA report, and your familiarity with the Heidelberg study; is that correct?

A. I would say that I would expect there to be a difference in the amount of such releases, based on the past differences of opinion between EPA and Heidelberg and the NRC.

Q. Okay.

Referring to your response to Question No. 6 in your testimony -- Do you have a copy still of your testimony?

A. Yes.

Q. At the top of -- or actually that portion of

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your answer to six, which appears at the top of the next page -- just above the Question 7 -- you refer to a Royal Swedish Academy of Science's article in August of '81.

A. Yes.

Q. Is that what you have offered as an exhibit here, Exhibit No. 14?

A. Could you --

Q. I don't know that you know the numbers of the exhibits, but maybe counsel could --

A. If you could hold that before me, I could identify it.

Thank you.

Yes.

Q. One of the reasons for my question is the copy that I had was dated November 1981. And your testimony refers to an August 1981.

In any event, we're talking about the same document, what you referred to in your testimony --

A. This was published in August. I don't know where you see the November date.

Q. On the cover sheet that I had on the document as it came to me.

It's most important, Dr. Johnson, that we're talking about the same document.

A. Yes.

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Q. Fair enough.

A. It clearly was published in August.

Q. Okay.

This article which was published by the Royal Swedish Academy of Sciences deals with a subject which you have addressed in several publications. Is that true?

A. That's correct.

Q. Is this document the latest or most refined analysis that you have done of this subject?

A. No. At the annual meeting of the American Public Health Association in November, I published the results -- a regression analysis of that data, rather I reported regression analysis of the data to the epidemiology section of the American Public Health Association.

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Q. Were there refinements or differences in that report from the document that we have in front of us?

A. Yes, it provided corroboration based on regression analysis of the data, but did not change the conclusions in this article at all.

Q. You didn't make any changes to your work in this article? This remains --

A. No, it would not affect this article.

Q. -- you stand behind this document?

A. No.

Q. You continue to stand behind this document that we have?

A. Yes. This article stands by itself. It's the first published report.

As you understand, the work continues. I'm funded by the National Cancer Institute to continue this study, looking at additional information, doing additional analyses.

This will continue for at least another year or perhaps longer.

JUDGE WOLFE: And Doctor, when you are speaking of the article or the report that you now have before you in this proceeding, you are speaking of Joint Intervenors' Exhibit 14; is that correct?

MR. JONES: That's correct, Your Honor. The

10-2

witness is not explicitly familiar with the numbering which was adopted --

JUDGE WOLFE: Yes. I just want our record to be clear here.

All right.

BY MR. BLAKE:

Q Doctor, referring to your answer to Question No. 11, you cite in that response a number of statistics, a figure for death rate of lung cancer for men who do not smoke and do not mine; is that correct?

A Yes.

Q Similarly, one for not smoking, but being a miner?

A Yes.

Q And third, for smoking and being a miner.

What is the corresponding statistic for smoking alone?

A That would likely be in the report. I don't have it here.

I can get that information for you.

Q Possibly over the lunch hour by call or by --

A By phone call tomorrow.

Q Tomorrow.

What are the substances in smoke and in mining which are responsible in your view for these statistics?

10-3

A. Oh, radon and its progeny, uranium, radium.

Q. Radium?

A. Yes, small amounts, depending on the level of exposure.

In cigarettes, of course, it's benspyrene. Some say, also, there are trace amounts of other materials which can be carcinogenic, too. Benspyrene is mentioned.

Q. What is your estimate of the amount of radon which is to be released by Waterford 3?

A. Well, the effects of radiation are non-specific, so I'm not really sure how relevant that is.

I don't know what the estimates are of radon to be released by Waterford.

Q. Do you have any estimate of radon to be released by Waterford 3?

A. No, I don't, but the point is that it's an example of synergism, an action between two or more substances, chemicals or physical agents, like ionizing radiation as a generic agent working together to cause negative or potentiating effect, a synergistic effect.

Q. Would you say that in your opinion synergism is independent of the substances involved?

A. Well, no. You can use a number of agents which would have an effect, a small effect individually. Together they may have a potentiating effect.

10-4

It describes the effect.

Q. If you observe a synergistic effect between the substances which are carcinogenic which result from smoking and from inhalation of radon, is it your opinion that smokers who inhale any radioactive substance could expect to see the same synergistic effect?

A. Well, yes, I think it's quite possible.

Q. Is that your opinion, yes?

A. Yes, it could be smoking and asbestos for asbestos workers. Or smoking and a virus, too.

Q. We started with smoking and radon, and I understood that radon is radioactive, and that was the effect or the carcinogen that was of concern to you here, rather than asbestos or --

A. This is given purely as an example of synergism.

In other words, I'm not saying that radon is the only agent which would work with smoking. It could be anything inhaled of an irritating chemical or physical effect, which could work synergistically with the paralysis products of cigarettes to enhance the expression of an effect, lung cancer.

Q. What we're dealing with here in this proceeding is the potential for synergistic effects which might result from operation of Waterford 3 nuclear powerplant.

10-5

A. Yes, exactly.

Q. And what I'm trying to understand is, is it your opinion based on your understanding of miners who smoke and, therefore, are exposed to both the carcinogenic substances in smoke and presumably radon, that you could anticipate seeing a similar synergistic effect based on people who smoke being exposed to releases from the Waterford 3 plant?

A. Yes, and there could be, also, exposure to carcinogens like chloroform in drinking water, an exposure to radioactive gases and particulates from a plant such as Waterford 3 or the Oyster Creek nuclear powerplant.

Q. Is it your opinion that radon will be released from Waterford 3 during routine operation of that plant?

A. No. My point here is that radioactive gases and particulates will be released from the Waterford plant in exhaust plumes and also in their liquid emissions.

Q. Is it your opinion that radium will be released from Waterford 3 during routine operation?

A. No. My point is there will be a large amount of radioactive gases and particulates of many varieties released --

Q. What do you mean by "large" --

A. -- not a single radionuclide.

10-6

Q. -- amount?

A. Of the order of ten thousand, a hundred thousand, a million curies of radioactive gases and particulates per year.

I would consider a thousand curies a large amount of radioactive gas. If it were a certain type of radionuclide like radioiodine or plutonium, very small amounts can be important.

Q. In your view, then, you might expect to see synergistic effects occur in individuals who smoke and who might be exposed to releases from the Waterford 3 plant, one million, one hundred thousand, ten thousand, and finally I thought I heard you say one thousand curies of radioactive gas?

A. It depends on which radiation type we're talking about. For example, some radioactive gases may be inhaled and be absorbed into body fluids, blood, lymphatic fluid, and then be excreted fairly rapidly.

Others like plutonium are stored in bone and have a very slow excretion rate of about one-half in two hundred years.

Also, it depends on chance and proximity. If the exhaust plume from the plant, because of weather conditions, flows along the ground -- and three of the six common plume patterns do at times flow along the

10-7

ground and you were living, say, 20 miles away and the plume comes your direction, and you are outside.

You inhale the plume. Then you are going to get a good dose of whatever is in the plume.

On the other hand, if you stay indoors all the time and your house is not well ventilated, then exposures may be less.

Q. Dr. Johnson, I asked you earlier today whether or not you were familiar with the expression Chi over Q. I think your answer then was no. Is that still your answer?

A. The expression Chi over Q? No, I don't work with formulae like that.

Q. Have you ever looked at the studies by others or evaluated yourself the meteorological conditions which are present at the Waterford 3 site?

A. No, I haven't. I understand --

Q. Let me return --

A. -- the environment is quite humid, that the water table is very high, that the plant is located on an important river, and at times you have hurricanes in the area.

There is some information of that order I have.

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11-1

BY MR. BLAKE:

Q. Dr. Johnson, were you involved in -- yourself or have you read reports which detected this -- what you have referred to here as the synergistic effect which occurs in uranium miners who smoke?

A. Yes. I have a report, and I'll send that to you, if you like. It's back in Denver.

Q. Did you participate in the development of any data or in that report itself, or have you just read it?

A. I have read the report, and heard the report, and discussed it with the senior author.

Q. Who is that, please?

A. That was -- Well, in this particular report -- It's by Lyndon, Archer and Wagoner. Wagoner has written other articles of which he was the senior author.

And he had just been at a symposium I organized for AAAS in January, as the sole author of a report which discusses cancer in uranium miners.

Q. And you've discussed this report with Wagoner?

A. That's correct.

I also invited him to present his material at a seminar sponsored by the State Department of Health on another occasion, in which he discussed the same materials.

Q. Now, based on this familiarity that you have

11-2

with the report and having discussed it with one of its principal authors, what is your understanding of the dose which the uranium miners receive from radon?

A. It's expressed in working level months. I can't discuss it in detail because I wasn't directly involved with it.

Q. Can you give me an estimate of what dose you're talking about or was discussed in those reports?

A. No. There's a table in the report which discusses the dose.

But the point is that there clearly was a synergistic effect, which is true not only in this example, but in many others. In pharmocology it's a well-understood phenomenon.

Q. Pharmocology involving radiation?

A. Pharmocology involving studies of synergistic effects between drugs.

Q. Between different drugs?

A. That's correct.

But you also have this effect between radiation and chemical agents as well.

Q. Do you have a copy of that report with you?

A. Which report?

Q. This report that you're relying on here, from which we might be able to determine what the doses

were.

A. Of the asbestos workers?

Q. Yes. Of the miners --

A. It's in my office in Denver. I'll need to send it to you.

There are other reports which discuss synergism between radiation and chemical agents.

Q. How many times --

A. I have one or two of those with me today.

Q. Would you describe, as a result of your discussions with one of the authors here, would you describe yourself as fairly familiar with this individual?

A. Describe --

Q. Describe yourself as being pretty familiar with this individual and his work.

A. Pretty familiar? Well, I know his name. I know where he lives. I know he was trained at Harvard, he worked in the Public Health Service for many years.

He has done a number of studies of uranium miners. And his work is pretty well accepted.

Q. Which one --

A. -- he's considered an expert -- Pardon?

Q. Which one of these individuals is it?

A. Joseph Wagoner.

Q. Could that possibly be Joseph Wagoner,

11-4

W-a-g-o-n-e-r?

A. That's correct. The word is misspelled here.

Q. I see.

What dose -- What is your understanding of the doses which will result from radioactive gases released from Waterford 3 during routine operation?

A. For a person who is in the exhaust plume as it blows through his back yard?

Q. Choose your method of describing it --

A. If I --

Q. -- I am reluctant to try to give you some, since you've expressed that you have not done any calculations, don't do calculations, are unfamiliar with the meteorology in the area, I'm reluctant to try to give you a bound -- You just describe it, however you wish.

A. Well, if I were working in my garden, say, 20 miles downwind from the plant on a day when the plume is along the ground, and I were inside that plume, the dosage I would receive would depend on the number of radionuclides released.

And there are 240 which are routinely released. It would depend on the concentration of each of those 240 radionuclides, and how much I would be inhaling, or -- inhaling, principally, and how much would be

11-5

retained in the body of each of those 240 different radionuclides.

If you can tell me the exact concentration of each of those radionuclides, I can go to any expert in the country and still not be able to come up with an answer, because nobody knows for certain.

Q. Can you give me in quantified terms your estimate of what you anticipate that people's doses will be from the Waterford 3 routine releases?

A. No, I don't do such dose calculations. And I discount those estimates because they are based on change of assumptions.

The people at Heidelberg have done such estimates. They point out that nonconservative assumptions have been made by the NRC and by the German and English equivalents, in making such dose estimates.

They did a study, for example, of the reactor proposed for the area around Vial, and they calculated doses to people in the area of about one rem per year.

Q. This is the same statement you've made in your prefiled testimony, is it not?

A. I believe so.

Q. So you have not made any dose calculations, and you don't know what the doses are that ill be

11-6

resulting from Waterford 3?

A. Not does anyone else at this point.

Q. That is, that's your opinion that the NRC's dose calculations may not be correct?

A. Yes.

Q. And your opinion is based upon your reading of the Heidelberg Report and problems as you understand it which that report points out?

A. That's part of the evidence, yes.

Q. And the rest of the evidence is?

A. The rest of the evidence is the record of very large releases or radioactive gases and radionuclides in exhaust plumes and liquid emissions from operating nuclear power plants, and also from the work by Dr. Ashekawa, who found that the plant which changes color in the presence of radiation, that much higher doses biologically have been observed in a biological monitor.

Q. I think I asked you earlier, Dr. Johnson, but in view of this answer, I'm going to ask you again, whether or not you can provide me with a single incident of which you are aware -- a single instance where a nuclear power plant in its routine releases has exceeded what was calculated prior to the plant's operation.

Your earlier answer, as I recall, was --

11-7

A. Well, the --

Q. -- you only had half the pie, and, therefore, you were unable to provide me an answer.

A. I would wonder about Three Mile Island and about the Oyster Creek reactor, the Windskill reactor, the Fermi reactor, Browns Creek Ferry -- one of the Browns Creek Ferry -- I would wonder about those.

But, again, I haven't seen their projected releases and the impact statements for those plants.

Q. Are you describing -- when you speak of TMI, you're speaking of TMI Unit 2?

A. Two, yes.

Q. And the accident that occurred in March of '79?

A. Yes.

Q. Would you describe that as a routine release? Is that what you meant?

A. Well, that's not a routine release.

Q. I see.

My question went to the routine releases --

A. This would be unusual -- Routine releases?

Q. Yes, sir.

A. Then I guess -- consider the Oyster Creek reactor and the other reactors, such as these five reported in the papers sent to me by the NRC.

11-8

And others. I've seen some others as well.

Q. And are you aware that with respect to this Table 1, that these releases -- these numbers on this table indicate actual releases which were greater than anticipated from these plants during routine operation; is that what your testimony is?

A. Well, again, I didn't see the projected releases for those plants.

As I said before, I haven't seen the projected releases for these plants.

Q. But it's your understanding that these numbers were the actual releases --

A. Calculated.

Q. Calculated based on actual releases or were they calculated based on projections?

A. These were supposed to have been -- I don't recall now exactly --

Q. Well, if you don't recall, how can you cite this for the proposition that actual releases from plants are greater, in your opinion, than what is calculated or expected or projected from the plants during routine operation?

A. Well, I think my point was that there have been large releases of radioactive gases and particulates from nuclear plants.

11-9

Q. And the examples which you cite for routine releases are Oyster Creek --

A. Oyster Creek and some other reactors listed by the EPA and these by the NRC.

I have another list I can produce for you, if you want to see it.

Q. Your testimony -- your response is in part based on this table, because you understand these to be actual releases from plants, and it's further your understanding that they are greater than what was estimated from these plants?

A. These were to represent actual releases, to represent. They obviously calculated the figures.

Q. What does "represent actual releases" mean? Are these based on actual source terms or actual release figures from the plant?

A. You'd have to question the authors.

Q. Now--

A. I didn't do the calculations.

Q. What is the basis for your testimony, Dr. Johnson? I want to know -- if I understand generally -- you are suspicious of the NRC's calculational techniques?

A. Yes, that's correct.

Q. And the basis for that suspicion -- Well, let me take one additional step.

11-10

Therefore, you doubt whether or not the NRC's projected releases and resultant doses from Waterford 3 during the routine operation will actually be what they're projected to be in the Final Environmental Statement? Is that also correct?

A. Yes. If during this time that --

Q. Excuse me. Let me finish if I can --

A. I'll answer the question if you like.

Q. I haven't finished the question yet.

A. I have a point here --

Q. And what I'm asking is: What is the basis for your suspicion -- and I understand that's in one part the EPA report, which found releases of neptunium. And so I'm asking further -- and you pointed to this table.

And now I'm trying to understand why you would cite this table.

A. For example, I look in this table and I find a certain figure for releases of neptunium from the Westinghouse pressurized water reactor. I find another figure -- this is picocuries per year -- 10 million picocuries per year neptunium 239 for the combustion engineering pressurized water reactor; 20 million for the Babcock and Wilcox pressurized water reactor; 8,600,000 for the General Electric boiling water reactor.

For the Oyster Creek reactor we have an EPA

11-11

report which showed a release of about five orders of magnitude more neptunium?

Now, who should I believe? The EPA or the NRC?

Well, I look at their emissions. The EPA's mission is to protect the environment.

The NRC's mission -- I'm not quite sure what it is -- their first priority is not to protect the environment. It seems to me. That belongs to EPA.

I tell you, I'm inclined to believe the EPA data. I wonder how the measurements are done -- are calculated for the liquid emissions of neptunium by these pressurized water reactors and the GE boiling water reactor.

- - -

12-1 ge

Q. How is a picocurie related to a curie?

A. A picocurie is 2.2 disintegration per minute. A curie is, I think, 10 to a 12th disintegrations per minute; 10 to a 12th, I think that's correct.

No, 2.2 times 10 to the 12th.

Q. Is the relationship between the two, to your knowledge, 10 to the 12th?

A. That's correct, yes.

Q. So for example, if we were to look here at this table where under Oyster Creek for Neptunium-239 there appears a figure with a lot of zeroes behind it, and I were to divide that figure by 10 to the 12th, what would the number be?

A. I'm sure you can do that. It would be .683.

Q. So the figure here would be .683 curies per year?

A. That's correct.

Q. And this was for liquid effluence in the year 1975?

A. That may have been '75. I'm not quite sure which year that was for.

Q. Are you aware of -- either do you have your own estimate or are you aware of an EPA figure for the same year?

A. Pardon?

12-2

Q. Do you have either your own estimate or are you aware of an EPA estimate for releases of Neptunium-239 from Oyster Creek during the same year?

A. I don't have an estimate. This was an EPA figure. That's what they reported for the releases for Neptunium in that year.

Q. Are you aware of an NRC figure for that year?

A. No, not for the boiling water reactor for Oyster Creek.

Q. Are you aware of an NRC figure for any of the elements shown on this table for any of the reactors shown on this table for the same time frame?

A. Well, I have asked for NRC figures. I received this report.

It's my understanding that these figures were NRC data, data they accepted at least, as calculated releases -- not estimated, but calculated releases.

Q. Are these EPA figures or NRC figures?

A. These are all NRC figures or figures NRC accepted, except for the one for Oyster Creek. That's an EPA figure. That's the sole exception in the table.

Q. How do you tell that? How do you know that, that that one figure on this chart is an EPA figure and all of the others on here are NRC figures?

A. I have a copy of the table from the EPA report

12-3

which gives the Oyster Creek figure in my briefcase if you want to see it.

Q. I see. Are you talking about the 6.8 curies?

A. That's in the exhaust plume. This is in the liquid discharges.

Q. The same EPA report --

A. Yes.

Q. -- provides a liquid release for this same year, which you think is '75, from this table --

A. Yes.

Q. -- which is different from this figure, or it's the same as this figure

A. The source of this figure.

Q. It is the source --

A. Yes.

Q. -- for this figure?

A. Yes.

Q. Do you have an NRC figure for that year?

A. No, not for that plant. I have it for the other plants.

Q. Why do you think that the EPA's figure is different from NRC's?

A. Well, I was impressed at the much larger amount of Neptunium-239 reported for the Oyster Creek plant than was reported for the other five plants, a

12-4

difference of about five orders of magnitude greater for the Oyster Creek plant for the EPA report.

Five orders of magnitude is very remarkable.

Q. Do you know what the failed fuel for Oyster Creek might have been in this year 1975 and in comparison to any other plants that are listed on here?

A. What's the question?

Q. Do you know what the failed fuel percentage might have been for Oyster Creek in 1975 relative to any of the other plants?

A. No, I don't.

Q. Do you know whether or not Oyster Creek might have in fact had higher neptunium releases in 1975 than other plants in the country?

A. I don't know that.

Q. Do you have an NRC figure for Oyster Creek in the same year to compare with this EPA figure which you are relying on here?

A. No. I asked for NRC figures and I received the report on these other four reactors which you see in the table.

But I didn't get the figures for the exhaust plumes. That was what I had specifically requested.

I was more interested in the exhaust plume content of neptunium, plutonium, curium, memorisium than

12-5

in the liquid effluents.

Q. Do you have the calculated releases done by EPA and done by NRC for any plant in the same period of time?

A. No, I didn't ask for that data. I did not receive it.

Q. So you have never compared NRC's estimates with EPA's estimates where you were looking at the same plant for the same period of time?

A. No. Still, I have a comparison between one plant and four others, monitored by two different agencies.

Q. Where you don't know what differences may have existed between those plants?

A. No, but it clearly is a comparison.

Q. I grant you it's a comparison.

Dr. Johnson, have you ever done any studies yourself of synergistic effects between radioactive substances and any other carcinogen?

A. No, I have not myself, personally.

Q. You have, however, read reports of some studies done of synergism?

A. Yes, I have a master's degree in pharmacology.

Q. And I think you said earlier that synergism between chemicals --

A. Yes.

12-6

Q -- is readily recognized?

A Yes.

Q Is readily recognized.

What reports have you read where synergism was the topic and that synergism resulted from some carcinogen and radioactivity?

A There's quite a good one which looks at the induction of mammary cancer by radiation and by a chemical agent, and with both chemical agent and radiation administered together.

There is a synergistic effect from the two.

Q Do you recall the authors of that report?

A I have a copy if you'd like to see it.

Q Do you recall what the dose levels were?

A I would need to refer to the report to tell you the dose levels.

Q Is that readily done or would you prefer to do that over the lunch hour?

A I can do it now, if you'd like.

Q If you'd like to wait? What did you say? I didn't hear you.

A If you want to save time, it can wait.

Q Why don't you take a look at that, if you will, over the lunch hour, please --

A All right.

12-7

Q -- to determine for me, one, the doses which are involved and, two, the dose rates.

You are familiar, I take it, with the National Academy of Sciences?

A Yes.

Q You are familiar with the BEIR Report?

A I've read the reports, two of them.

Q The latest BEIR Report which you've read was which?

A BEIR III.

Q BEIR III, 1980?

A Yes.

Q Are you familiar with what the BEIR III Report says about possible synergistic effects between uranium miners and smoking?

A No. I really am more familiar with the BEIR II Report.

The BEIR III Report was quite controversial because there was much division of opinion. I think a minority report was given, orally, anyway.

It's very controversial. I'm sticking BEIR II and waiting for BEIR IV, which I hope will resolve some of these issues with the new information that's been developed in the past year, for example, on dose estimates.

Q Are you aware whether or not any of the

12-8

controversy of which you speak had to do with the BEIR Committee's views on synergism or lack thereof between smoking and radon involving uranium miners?

A. No, I don't recall if that was an issue or not, but it certainly was controversial, the report.

Q. Do you have a copy of BEIR III with you?

A. Not with me, no.

Q. Would you check -- Over the lunch hour I'll provide you with a copy so that you can take a look and confirm whether or not the following statement appears in BEIR III?

A. I would do that, but I would not accept it as an authority, because it's not a -- it's a controversial report.

I think they are clearly wrong in many places in the report.

Q. The statement that I'd like to have you look at and see whether or not it appears in BEIR III, Dr. Johnson, states --

MR. JONES: Your Honor, might I ask that Counsel identify the reference point specifically, by page.

MR. BLAKE: The BEIR III Report, Page 268, the next-to-the-last paragraph on that page, and the sentence, "Cigarette smoking appears to lead to greater excess risk of lung cancer and radiation exposure when

12-9

smokers and non-smokers are compared, even though the data no longer support the view that radiation and cigarette smoking act in a multiplicative fashion in defining the cancer risk."

BY MR. BLAKE:

Q. I'd ask you again, Doctor, whether or not any of the controversy which you've referred to regarding the BEIR III Report, to your knowledge, surrounds this particular subject?

A. I don't know if it did or not.

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13-bm

BY MR. BLAKE:

Q. Let me refer you to your answer to Question No. 13 in your testimony. The first paragraph of your answer describes at the outset -- or makes reference at the outset to Dr. Ashekawa in Japan and his studies of the spiderwort plant.

Incidentally, isn't "spiderwort" one word?

A. It's one word, that's correct.

Q. That's another typo.

Have you done any studies yourself involving tratus cancia?

A. No.

Q. Have you ever calibrated yourself a tratus cancia plant?

A. No.

Q. Have you ever seen a tratus cancia?

A. Yes.

Q. Where was that?

A. In the greenhouse of Dr. John Cobb, Professor of Medicine at the University of Colorado, School of Medicine.

Q. Was that plant that you saw in the greenhouse used for indicating or detecting radioactivity?

A. I think he had some plans, but it hadn't been so used at the time I saw it.

13-2

Q The third sentence in your answer to Question No. 13, you refer to the plants grown around a nuclear power plant. Do you see that?

A Yes.

Q What nuclear power plant are you referring to?

A This was a nuclear power plant in Japan that Dr. Ashekawa used as a source of radioactive emissions. His hypothesis goes that the plants release several hundred radionuclides, many of which are radioactive isotopes of trace elements and other elements important in nutrition. And nobody really knows the effect of the molecular, cellular and developmental levels of these several hundred radionuclides.

Since many of them are concentrated in cell organals and chromosomes, as with the radioactive $B_{12}$ that I described, he feels that we need biological monitors to measure the biological effects of radiation. Like we used mouse units and frog units 40 years ago to measure the quantity of hormones in vitamins.

And I think the medical community in general agrees with this viewpoint.

Q What kind of a nuclear power plant was it?

A I don't recall which type.

Q What were the nature of its releases?

13-3

A. It would release at least several hundred radionuclides of the sort listed in 'Health Physics Journal" in April of 1980.

Q. What level of releases were involved?

A. Dr. Ashekawa mentioned that the plant personnel had published a report showing very small releases, which might produce a few millirems of exposure around the plant.

He decided to evaluate their -- you know, their published assertions with a biological monitor and found that, in fact, there -- at least in terms of biological effect, that a much larger effect was registered by the plants when you actually looked with a biological monitor.

Q. Are you aware whether or not this plant has ever been used for this purpose in the United States?

A. Well, I think that its use has not been accepted by a nuclear plant. I don't know of any plant that has a program to use any biological monitors, let alone tratus cancia.

Q. Do you know what type of x-rays were used for calibration of the plants used here?

A. No, I don't know the type of x-rays -- or that is, the energy -- I don't know.

Q. Are you aware whether or not tratus cancia is

13-4

very sensitive to different energies?

A. No, I don't.

Q. You don't know one way or the other?

A. The plants are sensitive to ions and to impacts by particular radiation or protons. As far as the plant itself is concerned, it doesn't care what the energy was or what the source was. It's sensitive to ions and the effects of radiation passing through the cell, you know, from the point of view as to which radio-isotope is going to do how much injury, it's very important to know what role it takes in metabolism, how it might affect the reproduction.

But the injury is non-specific, in terms of synerged by ions, free radicals, and synerged by impact by the beam itself.

Q. Are you talking about injury to the spider-wort plant?

A. Yes.

Q. And is it your opinion that the spiderwort plant and its response is independent of the energy level of radiation which is produced?

A. Not to the extent that the energy level may determine the number of ions created.

Q. Would you expect to see a different response from a spiderwort plant if you provided it with different

13-5

energy levels of radiation, but in the same quantity?

A. Although it would be different.

Q. So it would be different and would react differently as a function of energy?

A. That's not to say, though, that you can't calibrate a plant like this in a laboratory with a source of ionizing radiation.

I don't --

Q. Do you know --

A. -- know the details of the way --

Q. But you don't know what energy levels were used in this instance?

A. No, I personally don't know. I would rely on Dr. Ashekawa to know.

Q. Do you know what cell life cycles the plants were in that he used?

A. Cell life cycle?

Q. Yes, sir.

A. Well, these are growing plants.

Q. Do you know how old a spiderwort plant lives to be?

A. No, I don't.

Q. Do you know what the ages were of the plants that he was working with?

A. These are plants that are growing plants.

13-6

They haven't gone -- I don't believe they're plants that have gone to seed, because they're counting the injury to cells on the stamen -- stem hair cells.

Q. What age would the plant have to be in that configuration, where the cells are growing on the anther?

A. Well, mature enough to have blossoms.

Q. Do you know whether or not age of the plants that are used are important to the way in which they react to ionizing radiation?

A. Well, as you know, the life of a blossom is rather short.

Q. Are you saying that they react only during a very, very short period in their life? Are --

A. I know that when doing those, they are counted -- the mutations are counted frequently.

Q. I don't understand what you're saying, Doctor.

A. I'm sorry you don't.

What I've said is --

Q. Do you know how --

A. -- that a biological monitor is much more sensitive to radiation, a much better indicator of biological effect than calculations based on a series of assumptions, based on exposure to a rather small number of the actual radionuclides released by such plants.

That's what I'm saying.

Q. And now I'm asking you -- trying to get some feel for your understanding of Dr. Ashekawa's work that you support here. And I'm asking you whether you know how old the plants were that he used. And your answer is?

A. The answer is that he would plant tratus cancia around a point source, like a nuclear plant, and then periodically come by and count the mutations -- cell mutations.

Q. So this spanned --

A. These are young plants. These are not old plants. They're young plants.

Q. Young plants being less than a couple of years old?

A. (No immediate response.)

Q. What do you mean by "young plants"?

A. Plants which are still growing.

Q. Is that less than a couple of years old?

A. I don't know how long the tratus cancia lives.

Q. How long -- Over what period of time did he take these measurements?

A. I don't recall the exact period of time either.

13-8

Q. Do you know whether or not tratus cancia are sensitive to temperature or humidity?

A. I'm certain they're sensitive to temperature and humidity. They're plants.

Q. Do you know whether or not the way in which they react to ionizing radiation is a function of temperature and humidity?

A. I think that other factors like those are considered. You would do such a study with a control population. And as I said, you also can calibrate the plants with x-ray exposure in the laboratory.

Q. And do you know whether or not the atmospheric conditions under which the plants were calibrated by Dr. Ashekawa were the same as those in the field when these measurements were taken?

A. I don't know those details of the study.

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14-1 get

Q. Do you know what sort of instrument was used by Dr. Ashekawa to detect the changes in color?

A. He would need a high-powered glass to do that.

Q. A high-powered glass is what he used?

A. Or dissecting microscope.

Q. Do you know what he used?

A. No, I don't know what he used, but I think it's standard equipment in any botanist's laboratory.

It's certainly the equipment you'd use if you were counting cell mutations.

Q. The second part of your answer, in that same first paragraph of 13, refers to an EPA surveillance report on Oyster Creek which we've now discussed or at least referred to several times throughout the course of the morning.

Do you know what the issuance date of that EPA report was?

A. 1976.

Q. Do you know during what period of time the EPA took its measurements?

A. Well, in the report there are several periods they looked at. This particular figure , I'm not sure which year it was, '75 or earlier, but it is in the report.

Q. Do you have a copy of that report with you?

A. I have a copy of several tables from the report.

14-2

It's obtainable fro. ..e EPA, the EPA offices at Cincinnati where the report was issued.

Q. Would it surprise you to learn that the neptunium figure to which you've made reference was the result of EPA's work in '71 and '72?

A. It wouldn't matter. I'm interested in what the release is in a year in the plant.

Q. The neptunium figure which you've referred to earlier in a table for 1975 you also got out of this same EPA report?

A. 6.8 curies?

Q. The 680 figure on the Table 1 that you handed out today.

A. Oh, liquid releases.

Q. Yes.

A. Yes, that came from that report.

Q. Do you recall how EPA came by the number 6.8 curies?

A. No, I just -- oh, that.

I think there was some reference in the text as to how it was obtained.

Q. Pardon?

A. I think there was some reference in the text of the report as to how it was obtained.

JUDGE JORDAN: You spoke of 6.8 curies?

14-3

MR. BLAKE: Yes, I did.

JUDGE JORDAN: That figure I don't recognize.

BY MR. BLAKE:

Q. Dr. Johnson, the figure six curies of neptunium which appears in your testimony is the figure that appears in the EPA report, actually 6.8 curies?

A. 6.8. I should have rounded off to 7, but certainly it's in the ballpark.

Q. Do you recall how many times EPA looked for neptunium in the releases from Oyster Creek plant, as it's reflected in that report?

A. No, I relied on their methods.

Q. Do you know whether or not they looked on more than one occasion for neptunium?

A. I don't know, but I would think they would have looked more than once.

Q. Do you know whether or not they found it on more than one occasion?

A. No, I don't have the raw data from which they derived that figure.

Q. Have you read the report?

A. I've read it but haven't memorized it. I don't recall the details about how they obtained the data.

Q. If the report states that they looked on at least four occasions and on one of those were able to find

14-4

trace amounts of neptunium and then extrapolated that trace amount to produce the figure estimate of 6.8 curies per year annual release in that year, would that -- if that were the case, would your testimony remain the same?

A. Yes. If I thought about that, I would have thought the amount could be much larger.

Q. That is, you would have them extrapolate a greater amount than what they observed on one occasion?

A. They couldn't do that, but I think if you're having intermittent releases and you happen to catch one of those intermittent releases when measuring four times in a year, I think common sense should tell you that there may have been much larger releases undetected, unreported.

Q. Does it necessarily mean if you only pick up trace amounts on one occasion that there are intermittent releases?

A. Yes. What is an intermittent release?

Q. Do you know what the low levels are for neptunium detectability?

A. No, I don't recall.

Q. Do you know what level they picked up?

A. No, I don't.

Q. Do you know whether or not there could be neptunium there that they might not pick up because it's

14-5

below detectable levels?

A. As I said, I relied on the figure in the table. I think if they reported it in the table, they must have evidence for believing it to be there in the exhaust plume.

Q. Is your reliance on the figure independent of the method which EPA used to come up with that estimate?

A. Well, I think that I place a certain amount of reliance on the people in the EPA in doing what they are supposed to be doing.

Q. Do you know what the source would have been for this 6.8 curie estimate of neptunium?

A. The figure in the table in their EPA report.

Q. Do you know what the physical source would have been from the plant, how it got there, how it got out?

A. From the core.

Q. Pardon?

A. From the core. That is, from the fuel rods in the core, because aren't there some millions of curies of neptunium in the core of any reactor?

Any operating reactor would have some large amount. I think the figure is in the Impact Statement. Let's see, I have it with me.

Table 5-8 shows the projected content of the

14-6

Neptunium-239 in the core of the Waterford 3 reactor. I don't have it here with me.

You have millions of curies in the core of a reactor, which is a bit leaky; you could expect to find curie amounts of neptunium coming off in the plume exhaust, expecially when there are 1.2 million curies of radioactive gases escaping routinely each year.

Do you have the figure there for the number of millions of curies?

Q. I think you've already stated, Doctor, that you do not know what NRC calculated, if any, for neptunium releases from Oyster Creek during that same period of time?

A. No. I requested for that information and did not receive it.

Q. And you've stated that you don't know what period of time was involved in the EPA report? That is, you don't know for sure what year this 6.8-curie figure represents?

A. It was the figure they reported in their 1966 surveillance report --

Q. '76, I think, rather than '66.

A. -- 76, yes.

Q. But you don't know what years they did those studies in?

A. No. I was interested in what is released

14-7

routinely at this plant in a year's time, and that's what they had in the table.

JUDGE WOLFE: Mr. Blake, it's now time for recess.

How much more cross-examination, approximately, do you have, and I'll make the same inquiry of Mr. Turk?

MR. BLAKE: A lot.

JUDGE WOLFE: A lot?

MR. BLAKE: A lot, yes.

JUDGE WOLFE: We will recess until quarter of 2:00.

(Whereupon, at 12:35 p.m., the hearing was recessed, to reconvene at 1:45 p.m., the same day.)

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15-1
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AFTERNOON SESSION

1:45 p.m.

JUDGE WOLFE: Back on the record.

The Board has again been conferring, and we think with respect to the proposed conference call on April 16th that after conferring, we'll just have our secretary call the parties, if that's agreeable and advise whether or not we're granting the motion for reconsideration, and this to be followed by a written order explaining the basis for our ruling.

Is that satisfactory? No objection?

(No response.)

JUDGE WOLFE: All right. No objection.

Back to you, Mr. Blake.

JUDGE FOREMAN: Mr. Blake, could I just have a moment?

Dr. Johnson, I would like just a point of information. Could you tell us briefly how those plants are calibrated and just how that system works as a dosimeter?

If it can't be done in a few minutes, we will have to forego it. But if you can tell us briefly, I would appreciate it.

THE WITNESS: Dr. Ashekawa reported to a meeting at the University ofColorado Medical School about

15-2

three years ago that he took the plants into his laboratory and exposed them to measured doses of x-irradiation, and then based on the number of cell mutations counted after that exposure, he would extrapolate doses inside the cell in field locations around a nuclear plant.

That's all the information I have, Your Honor.

JUDGE FOREMAN: Okay. We'll let it go at that. Thank you.

BY MR. BLAKE:

Q Dr. Johnson, earlier this morning there were several times when we agreed that over the lunch hour you would check or look at some items. Have you had an opportunity to do that?

A Yes. I have an exact reference for the EPA report.

Q You say the EPA report?

A Yes. That came from the Office of Radiation Programs, Eastern Environmental Radiation Facility, Radiochemistry and Nuclear Engineering Branch, Cincinnati, Ohio, 45268.

That was 1976.

Q I think you were also going to check on the paper that you had on synergistic effects between radiation and carcinogens to determine the dose levels and the dose

15-3

rates.

A. The authors are Albert Segaloff and William S. Maxfield in cancer research entitled "Synergism Between Radiation Estrogen and the Production of Mammary Cancer in the Rat."

Q. Sir, my question was -- and what you were going to check on was what the radiation doses were that were involved and reported, and what the dose rates were.

A. The dosage was 800 remkins to the center of the mammary chain --

Q. What --

A. 800 remkins or rads -- 800 rads. And the rate was that dosage in 285 seconds.

Q. I was going to show you over the lunch hour the sentence which I had read to you out of the BEIR III report, and I neglected to do that. I'll do it during the next break, rather than taking the time to do it now.

MR. BLAKE: Your counsel has offered to look over my shoulder and stipulate that that is in fact what the BEIR III report says, and the sentence which I read earlier into the record appears at page 268 in the BEIR III report, and says, "Cigarette smoking appears to lead to greater excess risk of lung cancer from radiation exposure when smokers and non-smokers are compared, even though the data no longer support the view that radiation

15-4

and cigarette smoking act in a multiplicative fashion in defining the cancer risk."

MR. JONES: I will so stipulate that that statement appears at page 268 of the BEIR report, Your Honor.

JUDGE WOLFE: All right.

BY MR. BLAKE:

Q. Dr. Johnson, do you know what species of spiderwort plant Dr. Ashekawa used?

A. The genus is tratus cancia. I don't know the species.

If you have a --

Q. Do you know whether or not it is important that he calibrated these plants, one, in a greenhouse and, two, with x-rays, and then exposed them outside -- to use the detection mode -- and attempted to use them to detect all radiation which might have emanated from that plant in whatever form led to the radiation?

Do you know whether or not that's an important factor?

A. It could be important. If you have a critique of his work, why not enter it into the record?

Q. Do you know whether or not he did any studies of observed impacts or effects on people that were -- around the outside of this plant during the period of time

15-5

when the tratus cancia indicated that doses of over 100 rads were resulting from releases from the plant?

A. No.

Q. Would you as a doctor have expected that you might have seen some effects?

A. I would not expect a plant geneticist to do such studies.

Q. Would you as a doctor have anticipated that, in fact, if 100 rads were actually the dose, that observable effects might have been there?

A. Depending on any similarities between plant metabolism at the cellular level and in persons. And I think it's obvious that there's a need for such studies of human populations with similar exposures.

Q. Would you have expected if, in fact, the dose had been 100 rads in the area, to have seen any effects on the population?

A. I would want to do a study to find out, and I would try to avoid anticipating results. But I think you have to entertain the possibility of some effect.

Q. You earlier this morning indicated that one of the sources for your questioning of NRC release estimates, and maybe even those on this plant, although you're not -- you don't profess expertise on this plant -- was a "Health Physics" article which appeared in April of

15-6

1980.

A. That's correct.

Q. And is it your recollection of that "Health Physics" article that it dealt with or indicated in it the levels of releases which might occur from nuclear power plants, like Waterford 3?

A. I don't -- I'm certain Waterford 3 wasn't mentioned. I don't recall if it was.

Q. Plants like Waterford 3, commercial nuclear power plants.

A. I cited the article only because I recall a list of 240 different radionuclides important in routine emissions in the nuclear fuel cycle. And beyond that, I can't quote the authors -- or the author.

Q. Do you know whether or not it indicated how many of those 240 would be expected to come from light water reactors, as opposed to the other components in the nuclear fuel cycle?

A. No.

Q. You don't know or you --

A. I say that I do not recall.

Q. I see.

A. I don't recall.

Q. Well, I'm going to give you a copy of the article to refresh your memory, and then I'm going to ask

15-7

you the same question: Whether or not it identifies any radionuclides that come from light water reactors.

(Document handed to witness.)

A. Thank you.

Did you want to refer me to some page and line?

Q. Actually my reading of the article is that on the first page, in the lower right-hand portion of the page, it does indeed say that this article discusses the entire uranium fuel cycle.

But I myself have not found any statement in it which would tie the different isotopes discussed in that article to plants like Waterford 3.

A. That's not contrary to what I said.

Q. Certainly the record will speak for itself on what it was you said this morning.

Would you read the title of that article?

A. "Dose Rate Conversion Factors for External Exposure to Proton and Electron Radiation from Radionuclides Occuring in Routine Releases from Nuclear Fuel Cycle Facilities."

Q. Does the article deal with, in fact, the dose conversion factors; and does it not say anything about what the nature is -- what the quantity might be of releases from any component of the nuclear fuel cycle?

A. That is correct.

Again, that's not contrary to what I said.

Q. Assuming, Dr. Johnson, that EPA's estimate of the number of curies is correct for Oyster Creek in the report that you've referred to -- and that number is 6.8 curies -- what would that number -- what would 6.8 curies of neptunium mean in terms of numbers of curies of plutonium?

A. It would be a much smaller amount, because of a short half-life of neptunium.

Q. And a long half-life of plutonium?

A. Of plutonium, 24,400 years.

Q. What is the half-life for neptunium?

A. Oh, on the order of several days.

Q. Would you agree with me that it might be 2.34 days?

A. That's essentially what I said, I believe.

Q. And what would be the ratio of 2.34 days to some 24,000-plus years?

A. That is the ratio.

Q. What is that ratio?

A. Well, you just expressed it.

Q. What is the number expressed in orders of magnitude?

A. I would need a pencil and paper probably to do

15-9

that.

Q. Subject to check, assume for the moment that it's 2.6 times $10^7$, would you agree with me then that if Oyster Creek released 6.8 curies of neptunium, that in order to determine how many curies of plutonium that turned into, you would divide 6.8 by 2.6 times $10^7$?

A. Could you check your figure again? I wonder if it's correct.

Q. Why don't you go ahead and check me then now before we continue?

A. Do you have a calculator?

Q. I do not.

(Pause.)

I have one here. I don't know whose it is, but I can hand it to you if it would be helpful.

A. Thank you.

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16-1 ge

A. I get 3.8 times 10 to the 6th, not 10 to the 7th. It's an order of magnitude's difference.

Q. I can't imagine why we can differ. We are agreed that there are seven days in a week?

A. That's correct.

Q. Fifty-two weeks in a year?

A. Well, I can tell you how I did it very briefly. I multiplied 24,200 years by 365 days, divided that by 2.34 and that left days of neptunium.

If I punched the buttons correctly, I got 3.8 times 10 to the 6th.

Q. Dr. Johnson, do you know whether or not all of Neptunium-239 decays to Plutonium-239, or whether or not it may be a branching?

Do you know whether or not there may be a branching factor?

A. There may be, but the principal progeny is Plutonium-239. It certainly is the more important one.

I have a figure which shows plutonium is the principal daughter or product of neptunium in my briefcase, if you want to see it.

Q. No.

A. Okay.

Q. Dr. Johnson, do you know --

A. This doesn't show any side chain.

16-2

Q Does not show any?

A No.

Q What is it that you've referred to?

A Well, this is a figure from an early 1974 hearing on plutonium standards held in Washington. It's a figure I've copies onto a transparency.

It shows conversion of Uranium-238 in a neutron flux to neptunium with a half-life of 2.35 days becoming plutonium, and there's no side chain indicated.

Q Do you know what the background level is of plutonium in the United States?

A Well, there are several figures, two from South Carolina in a report by McLendon and others, indicate 35 femto curies of Plutonium 239, 240 per gram of soil from soil cores.

On the other hand, if you look at surface soil in South Carolina, the level is -- no, it's not 35. That's Colorado.

In South Carolina, it's a much smaller figure. I have that figure in a letter to EPA. I'm not sure I have it with me in my briefcase, but I can telephone it to you.

In Colorado it's 35 femto curies per gram for whole soil; for surface soil or surface dust it's 23 femto curies per gram.

16-3

In South Carolina it's more than an order of magnitude smaller.

Q. Do you know what the surface concentration might be as an expression of area, millicuries per kilometer squared or whatever other figures you would use for a concentration per area?

A. I think such figures are improperly used.

Q. Improperly used?

A. Improperly used, because the measurements are in fact taken per gram of soil and then, again, you know, sections are made to calculate area-wide concentrations which I think have little relevance to actual fact.

I think the only true measurements you can talk about in soil contamination are those made per gram of soil.

Q. Do you know what the --

A. For example --

Q. -- contributors would be to natural background or what appears --

A. Pardon?

Q. Do you know what the contributors are to background plutonium levels now?

A. Yes. Most of the Plutonium-238 came from the incineration of the Snap-2 vehicle when it re-entered.

The remainder of the plutonium came from

16-4

nuclear weapons testing in the atmosphere and some portion from nuclear plants, like the Savannah River plant and the Rocky Flats plant.

Q Are you familiar with a document called the UNSCEAR Report?

A Which?

Q UNSCEAR?

A Yes, I've seen the document and read parts of it.

Q Do you think it's inaccurate for UNSCEAR to report plutonium as a background due to fallout in terms of concentration of plutonium per area, per surface area?

A I don't think it's very accurate, no.

For example, in Colorado --

Q Do you know --

A -- and I think other nuclear agencies may use this convention as well, a gram of surface dirt is taken as one square centimeter. That's purely a convention.

There are assumptions there which make going from per-gram samples to area not very accurate.

Q Do you know what assumptions UNSCEAR used --

A No, I don't.

Q -- in developing its numbers?

Do you know whether or not there are others who share your view that it's not reliable to express

16-5

background levels of plutonium in a concentration per area of surface?

A. No, I don't know who else shares this view.

Q. Do you know what dose to the individuals you might expect from the releases of -- release over a year's time of 6.8 curies of neptunium from the Oyster Creek plant?

A. It's hard to say. Again, it depends on who is living in the prevailing path of the exhaust plumes from the plant, and how much time they spent outdoors in the plume at a time the plume is passing through.

Q. Do you know whether or not NRC in calculating anticipated doses for individuals offsite from a nuclear powerplant uses the very types of factors which you have referred to?

A. I haven't seen them use for plutonium or actinides.

Q. Would you use a different dispersion factor for plutonium in air than for other isotopes?

A. There could be a difference because plutonium is particulate, and as you know, a great deal of the exhaust from a nuclear plant is in the form of gases.

There must be some difference in dispersion. Heavier particles, like plutonium, will tend to fall out; smaller ones would tend to keep on dividing and scattering,

16-6

because of the alpha recall effect and not fall out.

Q. Do you know whether or not --

A. So there will be some differences.

Q. Do you know whether NRC takes these types of factors into account?

A. I don't.

Q. Do you have any reason to believe that they do not?

A. I don't.

Q. Do you know whether or not they take into their account of calculations of offsite doses by accumulation factors?

A. I'm aware that they have made some estimates based on the use of sterilized soil, but any agricultural scientist is aware that the normal flora and fauna of the soil, microorganisms in the soil are important in the uptake of elements and minerals in the soil by plants.

Q. Do you know, Dr. Johnson, whether or not -- Do you know what the figure is for the release of neptunium from the Waterford 3 plant during routine operation?

A. I saw a figure of three millicuries per year corrected to something on three orders of magnitude less.

Q. Do you know what dose such an amount of neptunium would result in for whatever you might use as the maximum, as assumptions for computing the dose to a

16-7

maximally exposed individual offsite?

A. The report of that figure is that it shows, one, there should be surveillance for neptunium and other actinides which come from the core; and secondly, that there should be more concern about releases which are not measured or reported.

MR. BLAKE: Judge Wolfe, I would move to strike that answer as totally unresponsive to my question.

JUDGE WOLFE: Could we have both the question and answer, please.

(The last question and answer were read back by the reporter.)

JUDGE WOLFE: Motion to strike granted.

Answer the question, Doctor.

THE WITNESS: Repeat the question.

BY MR. BLAKE:

Q. Dr. Johnson, I want to know using whatever assumptions you would use, and I'll ask you about those depending on your answer, what dose would you expect would result to a maximally exposed individual offsite from the release anticipated by Waterford 3 during routine operation?

A. I have no way of knowing.

18-1 ge

Q. Next, the second paragraph of your answer to Question No 13, the study by the Heidelberg Institute for Environmental Research; I think earlier today in your testimony you referred to the plant which that group studied as the Vial plant; is that correct?

A. Yes.

Q. What kind of a plant was the Vial plant?

A. I don't recall which type it was.

Q. Do you have any idea what releases were expected from the Vial plant or how they compare with Waterford 3's expected releases?

A. No. I'd refer you to the Heidelberg Report.

Q. So you don't know what the source terms were for that plant?

A. No, I didn't memorize those.

Q. Do you know what sort of meteorology was used in the Heidelberg Institute's study?

A. Again, I don't memorize such reports. I see probably hundreds of reports in a year. I don't memorize them.

Q. Well, you've not --

A. I can refer you to it. I think you probably have it in your possession in front of you.

Q. Well, you've not referred to hundreds of reports in your sworn testimony here. What I'm asking you

18-2

about are studies and reports on which you relied for your testimony.

A. I relied on the conclusions, and I did hear the report presented itself, but I don't memorize details of such reports.

Q. What did you do to satisfy yourself that the Heidelberg Report, at least its conclusions, were accurate?

A. I discussed the details of the report with one of the authors.

I visited the Institute itself and met some of the staff and discussed the report.

Q. What was the name of the author that you talked about it with, or do you recall?

A. I talked with Dieter Teufel and Baron Franke.

Q. Dieter?

A. Dieter, D-i-e-t-e-r, Teufel, T-e-u-f-e-l.

Q. And?

A. Baron Franke, F-r-a-n-k-e.

Q. Do you recall whether these individuals were professors at this Institute?

A. They don't have titles like professor at the Institute.

Q. What is the Institute?

18-3

A. It's the Heidelberg Institute for Energy and Umweltforschung, Environmental Research.

Q. What is the purpose of the Institute?

A. The purpose of the Institute is to study implications for health of various means of energy generation, like nuclear plants.

They look on other environmental effects, too. They have a study going on mutant frogs in a pond which had had radioactive waste dumped in it.

They do things like that.

Q. Are you aware of whether or not the Heidelberg Report has been accepted by agencies in this country?

A. I think it's been considered. Certainly, one report was translated by NRC and it's been presented to such prestigious associations as the American Association of Science, and I think it has had wide circulation.

Q. Do you know whether or not it also has wide acceptance?

A. Well, I'm not sure what you mean by that. If you mean has the NRC changed all their policies to reflect the Heidelberg Institute's input, I would say they probably have not and I doubt if they will.

Q. Do you know whether any agency or standard-setting body in this country has accepted the Heidelberg

18-4

Institute's work?

A. Well, you must understand this is a German Institute. It seems to me the criterion should be whether the West German government gives it any credence.

I would point out they did drop plans to build the Vial reactor based upon the Institute's report.

MR. BLAKE: Move to strike.

JUDGE WOLFE: Motion granted. Doctor, when you are asked a question, answer the question.

THE WITNESS: But Your Honor, he asked had it been accepted, and it's a German Institute.

BY MR. BLAKE:

Q. Doctor, my question was, do you know whether any agency or standard-setting body in this country has accepted the Heidelberg's Institute report?

A. Not yet.

Q. Not yet you don't know, or not yet has any?

A. The report has not yet been accepted here in this country by official nuclear agencies.

Q. Is EPA an official nuclear agency, in your view?

A. Well, it really is an environmental agency but they have an Office of Radiation Programs.

Q. Has EPA's Office of Radiation Programs accepted it?

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18-5

A. I don't know if they have or not.

Q. Do you know whether any agency in this country has accepted the Heidelberg Report?

A. No.

Q. Do you know whether in determining or calculating offsite doses from a nuclear facility it is important to have an accurate estimate of the meteorology in the area?

A. Yes.

Q. Do you know whether in order to obtain accurate meteorology it is important to gather your data at the same point with respect to wind frequency, wind direction, wind speed?

A. Well, yes and no. I'd want to know wind direction at several points, because in some areas wind can travel in a circular path or a path different than a straight line.

Q. You've done dispersion factors in the area around the Rocky Flats plant, have you not, Doctor?

A. No.

Q. You have not done any studies?

A. No.

Q. You've only measured what has resulted from the plants?

A. This is correct. I would maintain it is more

18-6

accurate.

Q. If you were to set about doing a dispersion factor, would you take at one geographic location what you observe to be the wind direction, at a second geographic location what you observe to be the wind speed, and combine those two to say you had an accurate idea on the meteorological conditions in the area?

A. No.

Q. You would attempt to get different parameters on wind at the same point or in fact, as I think you have observed, at several points?

A. That's correct.

Q. Do you know whether or not the Heidelberg Institute, whose work you've endorsed, in fact used joint frequency data?

You know what the term joint --

A. On wind direction?

Q. Yes, sir.

A. On wind direction. I'm not aware of how they arrived at the wind directions.

Q. Did you ever discuss with the authors of the report what they used to develop their Chi over Q values or their dispersion values or their meteorology which they used in assessing the doses?

A. My area of interest is the uptake of

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18-7

radionuclides, especially those which are radioactive isotopes of trace elements and also important in nutrition. Also, the --

Q. Doctor, is your answer no?

A. -- sterilizing of soil and not in wind direction.

Q. Is your answer no, you never discussed the meteorology which they used?

A. No.

Q. Your answer is no; is that correct?

A. That's correct.

Q. And you never discussed with the authors of the report, nor did you evaluate the report as to the source terms which they used?

A. No.

Q. Dr. Johnson, did you prepare a manuscript in 1979 entitled, "Epidemiological Evaluation of Cancer Incidence Rates for the Period 1969 to '71 in Areas of Census Tracts with Measured Concentrations of Plutonium Soil Contamination Downwind from the Rocky Flats Plant"?

A. Yes.

Q. What is the relationship of that manuscript to our Exhibit 14? That's the Ambio statement.

A. The Swedish paper is about nine drafts down the line from the first manuscript. It reflects input

18-8

from the critiques by a number of official agencies, university professors, presentations of two national meetings, scientific meetings, and two international congresses, including one on radiation protection in Tokyo and one in Israel, plus peer review by the Royal Academy.

Q. So that the Ambio Report is the most recent refinement of the manuscript which you originally published in 1979?

A. Which has been published.

Q. Which has been published?

A. Yes.

Q. Have you ever been involved in work assessing or evaluating the data based on the survivors of Hiroshima or Nagasaki?

A. No.

Q. Do you claim expertise in the statistical work and analyses based on studies of survivors of Nagasaki and Hiroshima?

A. No.

Q. Do you know whether or not standard-setting bodies like ICRP or NCRP have taken into consideration data and epidemiological and statistical studies of impacts on individuals in Hiroshima and Nagasaki?

A. I'm sure it's been considered. The largest study done of this type, I guess, even though severely criticized and considered controversial.

BY MR. BLAKE:

Q Have you criticized work on that?

A Yes.

Q Are you familiar with the studies?

A I have read a number of them. There are a large number of reports. I've talked with Dr. Finch, who is one of the key workers.

Q What is the nature of your criticism?

A Well, my criticism is that the two nuclear bombs were dropped on these two cities in 1945. There's a great dispute over how many people were killed by the explosion at Hiroshima and in the years after.

But it's clear there was a very high death rate. And then when the study teams arrived five years after, they began counting heads and building their registry of survivors.

Well, I would consider this a group of hardy survivors and not typical of the general population. But I think that the way the statistics have been treated has been as if they were derived from a normal population.

We maintain that -- I would maintain that in a normal population, about one-third of the people have two-thirds of the illness. After a holocaust of this sort, you would expect to find the heaviest fall among the people most susceptible to disease, and the group

17-2

remaining would be a hardy group, somewhat similar to what has been described as a healthy worker effect.

Q. Where has your critique been published?

A. Oh, I didn't say I had ever published it. I just say this is a criticism I have.

Q. This is a view which you hold, but have you --

A. A criticism.

Q. But have you written it down -- this criticism?

A. No, I've never claimed to have published it.

Though I told Dr. Finch about it, which should be as good ... in the nature of a suggestion, why not consider the survivor effect for the group of survivors and not present them as a normal population.

In fact, I think he now at least at meetings concedes that there may be a survivor effect, although you can't really -- he doesn't really go further with it.

Q. Your response to Question No. 15: You refer to -- or you state that the fetus is considered about 20 times more sensitive to radiation than the adult. What is the basis for your opinion of 20 times?

A. I saw a table which -- actually you can break it down farther, in terms of trimester and the age in years through childhood -- it's an order -- or the order of difference of that sort.

The fetus is certainly more sensitive than a child, and on the order of about 20 times more sensitive. I think you can argue about just how much, depending on what period of the pregnancy exposure takes place. This will vary.

A child -- a young child is more susceptible to radiation than an older one, I think, on the order of about ten times more susceptible is all right to say.

Q. Do you know what table it is that you're talking about that you saw?

A. I can't recall now. I could find the table for you, which I can mail later.

I don't have one with me.

Q. Would you agree with me that ten times may be the upper bound on what's generally accepted for fetuses?

A. I think I've seen more than that.

Q. You say you think you've seen more --

A. I have seen a reference with more than ten times higher for susceptibility for a fetus.

Q. You say a reference that has --

A. I think I can find it, yes. I thought it was pretty generally known.

Q. Your response to Question No. 16 -- the second sentence of that answer, in particular -- does that mean that you subscribe to the linear relationship?

Z-4

A. Well, the linear relationship, as are usually considered, refers to something different -- the relationship between exposure and the effect.

Q. Would you have to assume the linear relationship in order to make the statement which you've made in the second sentence of your answer to 16?

A. Well, I don't really see the linear relationship is going to apply, because conventionally in looking at radiation, this is the relationship between dosage and effect, and not comparing small doses to a large dose of the same order.

Q. Isn't your statement that you would expect to see the same effect if you received one rem over 30 years, as if you got a single exposure of 30 rems?

A. The BEIR II Report refers -- actually to an older report by the Federal Radiation Council in which they consider a five-rem dose as being roughly the same as 170 millirems over 30 years.

So those two bodies have looked at this relationship like this.

JUDGE JORDAN: Did you perhaps misspeak or miswrite? Did you mean one rem per year over 30 years?

THE WITNESS: Yes. That's missing -- one rem per year over 30 years.

We're speaking of annual doses, I thought, so

an annual dose of one rem over 30 years would be equivalent to 30 rems.

That's a shorthand way of speaking, and I assumed no one would misunderstand me, that by one rem over 30 years, this is a one-rem annual dose.

Q. Are you familiar -- I think earlier today you said that you had some familiarity with BEIR III, but that you were still abiding by BEIR II because of the controvery which had surrounded BEIR III. Is that a fair summary of what you said about BEIR III?

A. I find myself still citing BEIR II.

Q. Do you know whether or not -- what BEIR III says with respect to the linear relationship?

A. There was dispute over that.

Q. Do you know what it says, or what it says is the relationship?

A. I don't really know because I discounted that when I heard about the argument that took place over it.

There was so much disputation there could scarcely be anyone with the whole truth.

Q. Do you know whether or not the relationship which has been advanced in BEIR III is referred to as the linear quadratic?

A. I have heard of that approach.

17-6

Q. Do you know whether or not the linear quadratic has been accepted by standard-setting bodies, like ICRP and NCRP?

A. I don't really know because I discount the ICRP and NCRP as being loaded with people tied in with the industry.

I look to the EPA for what little it does in this area and look to people with expertise in the area of the public health orientation, because my field is public health; and I feel that the nuclear agencies have pushed public health down the line somewhere in priorities.

Q. Have you had any dealings with the ICRP or the NCRP -- you yourself?

A. No, I have not -- am not a member.

Q. And do you know any of the individuals who serve on those bodies?

A. Yes. I know the person who was active for some 20 years -- the person who was chairman and served on dosage committees of the NCRP and the ICRP.

Q. And who was that?

A. Dr. Carl Morgan.

Q. With respect to your answer to Question No. 17, you refer to studies of two populations exposed to high background low-level radiation.

A. Well, low level -- I think that's a -- has

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been mistyped. I think the tape probably said "low-level" -- "high background ionizing radiation."

I don't think I would say that. But I don't see how that changes the meaning anyway.

Q. Do you want to change that statement now to read --

A. I would just say "high background radiation."

Q. All right.

A. The other two words are redundant.

Q. Where geographically were those two populations located?

A. One is in Costa Correla in Southern India, and the other is in -- I think in Brazil, as I recall.

Q. What were the levels of background radiation?

A. Well, you're asking me to recall something from memory.

The way I remember it is that in Brazil, the background levels were about 800 rads per year -- or rem per year -- 800 rem per year of thorium sands.

And there they found about a doubling of the rate of chromosome aberrations in peripheral lymphocytes compared to other villagers who did not live at a high background area.

JUDGE JORDAN: Did you mean 800 rem?

17-8

THE WITNESS: 800 millirems, pardon me. I misspoke.

JUDGE JORDAN: Thank you.

THE WITNESS: Yes, about 800 millirems.

In Brazil the levels were higher. As I recall -- again from memory, as I remember it, 1500 to about 3000 millirems.

And there the rate of chromosome aberrations were nine times higher than other Indians in the area without high background radiation. And the rat of mental aberration -- pardon me -- the rate of mental retardation was increased fourfold over those other villagers in the area without the high background radiation, principally of the genetic type, mostly Downes' Syndrome.

BY MR. BLAKE:

Q. Were you involved in these studies?

A. No.

Q. You've read the studies?

A. I've read them.

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19-1
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BY MR. BLAKE:

Q. Do you recall when these studies that you read and about which you've now reported were released?

A. No, I don't.

Q. Do you recall ever having seen any critiques of them?

A. No.

Q. Do you know whether or not they've been accepted generally by the scientific community?

A. I've heard them widely quoted. I've never seen a critique.

Q. With respect to your answer to 18, isn't the risk associated with exposure either from internal or from external sources a function of dose and dose rate?

A. Yes.

I had an example -- I was hoping you'd ask for one.

Q. With respect to your answer to Question No. 19, have you studied or evaluated the hydrology or geology in the area of Waterford 3?

A. I understand that the water table is high in that area, and that's -- and also it's near a large river. And that's really all I know about it.

Q. You're not familiar either with aquifers or aquicludes which may exist in that area?

19-2

A. No. I haven't seen a map showing the aquifers there, where they flow.

Q. Nor --

A. It is near a river. I have assumed there would be some point of entry for the area -- of an aquifer into the river ... springs.

Q. You would assume that, but you've not looked at it or studied --

A. No. But there's a high-water table.

Q. Do you know what the sources of wells are for people who take drinking water in the area?

A. No.

Q. In the second sentence of your answer you refer to an experience in South Carolina with tritium. Do you know what the source was of the tritium?

A. Yes. One of five nuclear reactors at the Savannah River plant.

Q. Do you know what the source term was, how much tritium might have been released?

A. Yes. The official reports indicate on the order of over a million curies per year for a number of years were released.

Q. Do you know what the estimated release is of tritium is from the Waterford 3 plant in its liquid effluent?

A. No.

Q. In your response to Question No. 20 in your testimony, in the last sentence you've referred to several publications, which have addressed the general problem area, I take it, of synergistic effects in Louisiana -- or maybe it's just synergistic effects.

A. General.

Q. General synergistic effect?

A. That's correct.

Q. Some of these several publications which you refer to here involve radiation together with another carcinogen?

A. Yes.

Q. And can you identify any of those other than the document which you've already identified and we've discussed?

A. I have another -- Oh, well, the one on the uranium miners is one such example. Smokers -- the uranium miners who smoke.

Q. And I think we agreed earlier that you didn't know what doses were associated with the miners?

A. That was not my report, so I don't know the doses, and I shouldn't be expected to know them. But I can give you the reference which will give you the exact dose.

19-4

Q. Have you done any reports in this area?

A. No work of my own, no.

Q. Is it those two reports -- that is, the one on mammary glands of rats, I believe, was one --

A. Yes.

Q. -- and the smokers -- uranium miners -- smokers report which you've referred to earlier in your prepared written testimony?

A. I have seen several others. I'm not -- I don't have them with me today. I can provide them.

Q. You've seen several other reports involving --

A. Synergism.

Q. -- synergism between carcinogens of some type and radiation?

A. Yes, I have. And I may have left them in Denver. But I can provide them.

Q. Do you recall what the doses were that were discussed in these reports and the dose rates?

A. No, I don't.

Q. Have you studied or evaluated the levels of chemical contamination which exist in the Mississippi River in the area of the Waterford 3 plant?

A. Yes, I have seen one of those reports.

Q. I say: "Have you studied or evaluated yourself?"

19-5

A. Oh, no, I've done no personal studies.

Q. But you have read a report?

A. That's correct.

By Harris, Paige and Reiches.

Q. When did you read that report?

A. I had this report last week before I came.

Q. So you did not have it at the time you prepared this testimony?

A. No, but I knew of other studies that I had -- there were reports presented -- I think there may have been one at the American Public Health Association annual meeting on the topic.

At least I've heard the reports presented before. And I think the American Journal of Epidemiology has a recent report. I subscribe to that.

Q. So you think there have been reports --

A. I think there have been reports --

Q. -- published on this --

A. Yes. I have seen a report or two before. And then I took part in one of a series of symposia on hazardous wastes presented in Denver by the EPA and the American Public Health Association. I was one of their speakers.

And one of the other speakers there discussed the situation here as well.

19-6

It's a problem which has, I think, gotten some national attention, not only at the scientific meetings like this EPA report, but in other literature as well.

Q. Do you know what the levels of these contaminants are?

A. No, I don't recall the exact levels, but they're in the report.

Q. "In the report" being the Paige-Harris report which you read last week?

A. Yes.

Q. Is there any study, Doctor, which you have read which discusses the synergistic effect of carcinogens -- chemical carcinogens with low-level radiation?

A. The study of uranium miners who smoke and don't smoke, I felt this to be an example. And I have seen several others as well.

Q. Which discuss or report on studies of the synergistic effect of chemical carcinogens and low levels of radiation?

A. Radiation -- ionizing radiation, I'm not sure if you want to dispute what's low-level radiation or not.

But the animal study certainly is high doses. In order to make a study of carcinogenesis manageable, high doses are often used in order to induce cancer early

and make such studies possible.

I think extrapolations are drawn from that to human populations, which live much longer which have sub populations which are more susceptible to carcinogens than others -- less homogenous than experimental animal populations.

And I think the principle is well established that you do use higher doses of radiation in doing animal studies. You can extrapolate then from a study, say, with 20 animals or 50 animals as high doses, to a population of, say, 100,000 with low doses, if you assume the linear effect between dose and effect with radiation.

Q. Do you feel qualified to provide that opinion?

A. Yes.

Q. Having done no studies of synergistic effects and having read a couple of studies which involve radiation effects with other existing carcinogens?

A. That's a concept --

Q. That qualifies you --

A. That's a concept used in pharmocology, too. I have a Master's in pharmocology. And while I haven't studied such effects directly, I think I can say that I know something about it.

Q. So the basis for your opinion is your work in

pharmocology and your training --

A. Only in part. I'm also a physician.

Q. Your training as a physician, your Master's in pharmocology and --

A. And in Public Health.

Q. Pardon?

A. And in Public Health.

Q. And in Public Health --

A. Yes.

Q. And having read a couple of studies?

A. No, I've read many such studies.

Q. Many studies on synergism and --

A. On drug effects.

Q. Pardon?

A. On drug effects.

Q. On drug effects?

A. Correct.

Q. Which included the potential effects of radiation?

A. Some of them.

Q. Of which you're able to recall two?

A. Well, I have seen more. I think I can send you some more.

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20-1 ge

Q. In your answer to Question No. 21, you make the statement that members of the Commission in the past have been drawn from the industry or from nuclear agencies which support the nuclear industry.

Are you familiar with the current NRC Commissioners or most recent past NRC Commissioners?

A. I have a "New York Times" article which gives a brief bio summary on members. I think there have been several changes since that article.

Q. Would you number the current NRC Commissioners or the recent past ones, such as Commissioner Bradford who just left the Commission, in this sentence?

A. The panel I looked at somewhat closely was the one sitting at the time of Three-Mile Island, 1979.

Q. And included Commissioner Gillinsky?

A. Let me see if I have that. I may have that in my briefcase.

Q. You don't recall from memory any of the names of the NRC Commissioners?

A. No, I don't remember names like that. I refer to a reference.

I also have a roster of the members of the National Council for Radiation Protection Measurements, which lists their affiliations.

I don't have it with me, but I recall seeing

20-2

the list and most of them had prior association with the Atomic Energy Commission or with other sort of agency affiliations.

I can have a list to you in the mail tomorrow, but if you don't know already who those people are....

Q. I was really curious, Dr. Johnson, as to how well-versed you might be on this subject, having made the statement that you did in your testimony.

A. I'm prepared to back it up.

Q. But not today?

A. Well, I apparently don't have it with me today.

Q. "The NRC," you say next, "is not noted for having any great interest in public health."

A. Yes. I haven't seen any indication that their priority is public health.

Q. Does that translate in your mind into it's "not noted for having any great interest in public health"?

A. That's my assessment.

Q. And what is the basis for that assessment?

A. Well, I question why there isn't a surveillance of actinides released in the exhaust plumes from the plant.

I question why there can't be adequate

insurance for residents of areas near nuclear installations in case the plants should blow up, have a meltdown.

I haven't seen any positive indication that public health is at the top of their list of priorities.

Q. The next statement that you make is that the NRC's "mission is to serve the industry."

A. That's my belief, yes.

Q. Beyond that, you refer to "the arrogant officials, formerly of the AEC, now reside with the NRC, DOE, and the Office of Radiation Programs of the EPA."

Who are you referring to there?

A. Well, in the EPA I'm aware that the current Acting Director of the Office of Radiation Programs is a Mr. Gordon Burley, who is a former AEC officer, now in charge of radiation programs for the EPA.

I found him to be arrogant in my opinion. I think that's fair to say. I've been at a meeting at which he was present.

I found, in my opinion, him to be arrogant.

Q. Others?

A. I think in covering the activities of AEC--pardon me, the NRC during the conduct of Three-Mile Island accident, I felt that there was a certain arrogance.

Q. You are referring to your one visit to Pennsylvania?

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A. I'm referring to watching on television the reports by various officials during this event, the Three-Mile Island accident.

Q. Based on your television viewing of officials following the Three-Mile Island accident, you now make this statement, plus your having observed Mr. Burley, apparently, of the EPA?

A. I felt that when I requested information on releases of actinides by nuclear plants' exhaust emissions, that I shouldn't have had to wait for six months and then get a report about some other type of emissions.

Q. Who, again, was that? That was the Commissioner whose name you can't recall?

A. That's correct.

Q. Who was formerly with the AEC?

A. No. He's with the NRC. I don't know who he was with formerly.

Q. I'm asking about your statement in your testimony that says, "The arrogant officials, formerly of the AEC, now reside with the NRC, DOE, and the Office of Radiation Programs of the EPA."

A. Well, AEC. For example, there is the sheep incident, an area where the calculated total dose was four rads to sheep in northeastern Nevada and southwestern Utah.

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The sheep were reported later to have had doses internally of 15,000 rads to the gastrointestinal tract, 35,000 rads to the thyroid. Over the area, it was thought they had accumulated a dose of four rads.

Q. Are you going to come down to an official?

A. Now, the sheep -- pardon me, I'll talk about the AEC for a while, if you like, about arrogance.

Q. Are you going to come down to an official and give me the name of an official that you are referring to here?

A. Well, the AEC officials who provided oversight, the conduct of AEC in covering up the deaths of sheep, leukemia deaths of children and other effects of fallout during nuclear weapons testing in the South Pacific and in the Nevada -- at the Nevada Test Site, I would classify that activity -- or rather, their attitude as arrogant.

Q. And those individuals who covered up something, in your opinion now reside with the NRC, DOE, and the Office of Radiation Programs?

A. Some of them do, yes. Some of them do.

Q. Who are those?

A. Well, Mr. Burley was formerly with the AEC.

Q. Is that the individual whom you have already named who is at EPA?

A. Yes, and then several members of the NRC were

20-6

formerly with AEC, too.

Q. Who is that?

A. Well, I have their names and I'll send them to you tomorrow.

It's in a short article published by "New York Times," I think about a week or two after Three-Mile Island.

Q. This short article that you're referring to --

A. In the "New York Times" --

Q. -- provides the resumes?

A. -- there's a paragraph of bio data about each Commissioner.

Q. Does this article refer to them as arrogant officials?

A. This is purely my opinion.

Q. But it provides the name of the current NRC Commissioners --

A. Well, current at the time of the article.

Q. And from that article you were able to determine that they were formerly with the AEC?

A. Yes, I think for some of them they mentioned prior association with the AEC.

Q. Turning to your answer to Question No. 22, what is the basis for your statement concerning "the 240 radionuclides of importance released by nuclear power

20-7

plants such as that proposed"?

A. That's the "Health Physics" article, which you showed it to me again.

Q. And which we now agree in fact does not identify 240 radionuclides which will be released from plants like Waterford 3?

A. Well, the sentence reads something differently, I believe. I say, "Further, I doubt very much that actual exposures will be as small as this," meaning those proposed, "especially when you consider the biological effects of the 240 radionuclides of importance released by nuclear power plants such as that proposed."

This is a nuclear powerplant, and I'm assuming that being a nuclear powerplant, it will be the sort of plant considered by the author of the article in the "Health Physics Journal."

Isn't that what it says?

Q. You have read the sentence. What I am asking you is what is the basis for your statement, the thought expressed in there that there may be some 240 radionuclides of importance released by Waterford 3, which is the sense I get from that sentence?

Is that not what you intended by that sentence?

A. "By nuclear power plants such as that proposed."

Q. You didn't mean to infer from that sentence,

20-8

for people reading this testimony, that there might be 240 different types of radionuclides of importance --

A. I'm inferring --

Q. -- released by Waterford 3?

A. I am inferring that, yes.

Q. And I'm asking you what is the basis for your inference?

A. The "Health Physics" article, which states that these are the 240 radionuclides of importance routinely released by the nuclear powerplants.

Q. Doesn't it say by the entire uranium fuel cycle? Isn't that the sentence you read?

A. May I see it again, please?

(Document handed to witness.)

A. Thank you.

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21-1

THE WITNESS: Nuclear fuel cycle facilities, I take that to mean principally nuclear plants.

BY MR. BLAKE:

Q. Do you regard a uranium mine to be similar to the Waterford 3 nuclear power plant?

A. It's not similar. I know that they don't release neptunium.

Q. Do you regard a mill -- uranium mill as similar to the Waterford 3 nuclear power plant?

A. No. They don't release neptunium, or many of these other radionuclides listed here. You'll find most of those are fission or activation products.

Nearly all of them are fission or activation --

Q. Do you regard --

A. -- products.

Q. -- a uranium or fuel production facility as similar to Waterford 3?

A. No.

Q. Do you regard the reactors located at the Savannah River facility as similar to Waterford 3?

A. Yes.

Q. All of the facilities at the Savannah River plant you would regard as similar to Waterford 3?

A. The five nuclear reactors, three of which are still operating. They have reactor cores like the Waterford

21-2

3 reactor will have, and their releases will be similar in nature.

Q. Would you regard a million curies of tritium released a year as similar to 400 curies of tritium?

A. That's hard to say because the public wasn't told about the large releases of tritium for a very long time.

Q. Doctor, what difference does it make whether the public was told? I'm asking you whether or not you consider a million curies of tritium a year to be the same as 400.

A. Can we believe that this will be 400 curies? Why not four million curies? Who's to say?

MR. BLAKE: Motion to strike.

JUDGE WOLFE: Motion to strike granted.

Answer the question.

BY MR. BLAKE:

Q. Do you regard, Dr. Johnson, one million curies of tritium a year to be the same or similar to 400 curies?

A. Of course not.

Q. Dr. Johnson, the last sentence in your response to Question No. 21 states: "We must look to the DHH with its Center for Disease Control and its National Cancer Institute for protection."

21-3

The sentence before that states: "The only agency to which we can look for support is the Department of Health and Human Resources, which is the only federal agency whose primary mission is the protection of public health."

A. That's clearly a typo. That's Department of Health and Human Services, and that's DHHS.

Q. Do you still today subscribe to that view?

A. Yes.

Q. Are you aware that in the Final Environmental Statement which you say that you have reviewed, that the Department of Health and Human Services has reviewed the NRC's work which evaluated the anticipated effects from Waterford 3 and state: "It appears that the design objectives of 10 CFR Part 50, Appendix I, in the proposed operationg plan of Waterford 3 provide adequate assurance that the potential individual and population radiation exposures meet current radiation protection standards," and signs off on this document?

A. I didn't notice that. I wouldn't accept that anyway. I want them to do the surveillance.

MR. BLAKE: I have no more questions.

JUDGE WOLFE: We'll have a 15-minute recess.

(A short recess was taken.)

JUDGE WOLFE: All right.

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One last bit of information for you, Mr. Jones.

MR. JONES: Yes, sir.

JUDGE WOLFE: You may send your response to Applicant's motion for reconsideration to my attention at Howard Johnson Motel - West Lodge, 7953 Katy -- that's K-a-t-y -- Freeway, Houston, Texas, 77024.

MR. JONES: Judge Wolfe, if I may, I'd just like to read this back to confirm it to you.

Howard Johnson Motel - West Lodge, 7953 Katy Freeway, Houston, Texas, 77024.

JUDGE WOLFE: Yes. And, of course, you will send, also by express mail --

MR. JONES: -- copies to both members of the Board and the opposing counsel.

JUDGE WOLFE: -- and the necessary numbers to our Docket Clerk.

You had finished, Mr. Blake?

MR. BLAKE: Yes, sir.

JUDGE WOLFE: All right. Mr. Turk.

CROSS-EXAMINATION

BY MR. TURK:

Q Dr. Johnson, in your cross-examination testimony a little bit earlier today you were referring to a change made to one of the tables in the NRC Staff's Final

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Environmental Statement. That change concerned the value for the release of neptunium from the Waterford 3 plant.

Do you have any evidence whatsoever to bring before this Licensing Board which would indicate that the reason stated for that error, namely, that it was a typographical error, is incorrect?

A. No.

JUDGE WOLFE: Off the record.

(Discussion off the record.)

JUDGE WOLFE: Back on the record.

BY MR. TURK:

Q. In your cross-examination testimony earlier today, we were looking at a table, which bears the title "Calculated Releases of Radioactive Actinides and Radioiodine 131 in Liquid Effluents from Selected Light Water Reactors, In Picocuries per Year."

That's the table on which is the figure for Oyster Creek. For neptunium it is 683 billion curies of release. And then there are four other nuclear power plants listed there.

Do you have that table in front of you?

A. I will find it.

MR. JONES: Your Honor, for the record, both Mr. Blake and I would like the Board to note that the figure in the table referred to by Staff counsel is for

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picocuries per year.

JUDGE WOLFE: Yes.

MR. TURK: Forgive me. I meant to say "picocuries."

BY MR. TURK:

Q. Do you have a copy of the table in front of you now?

A. Yes.

Q. Is it your testimony that the other four nuclear plants which are listed on this page are actual nuclear power plants?

A. Yes, that's my belief.

Q. So that the figures in picocuries which are found under the four columns for nuclear reactors, those are the releases at some existing plant somewhere in the country?

A. Yes.

Q. Do you know, for instance, in the first column it reads, "(1) Westinghouse." Where is that nuclear plant located?

A. I would have to get the original report which I do have in Denver.

JUDGE WOLFE: And this original report is captioned what, again, Doctor, that this page -- this Table 1 is an excerpt from?

21-7

THE WITNESS: Well, I prepared this table, Your Honor --

JUDGE WOLFE: Oh, you prepared it?

THE WITNESS: -- from tables in that report.

JUDGE WOLFE: I see.

THE WITNESS: For benefit of physicians and others who don't work with very large negative exponents, I transposed those to the figures you see here.

JUDGE WOLFE: So this is your table with your caption; is that correct?

THE WITNESS: That's correct.

JUDGE WOLFE: And the name of the report that you extrapolated from to make up this table is called what?

THE WITNESS: "Doses from Radioactive Actinides Released in Liquid Effluents from Light Water Cooled Nuclear Power Reactors."

JUDGE WOLFE: And that was prepared by whom?

THE WITNESS: By Malaro, J.C. and Essig, T. H. They presented that at a meeting in Buffalo, New York in 1975.

BY MR. TURK:

Q So that the figures that appear on this table

are not presented in any way exactly as they appear in the report from which you drew the numbers? This is your tabulation only?

A. This is my tabulation. These numbers appear in this report, but with large negative exponents, times $10^{-12}$ or whatever.

Q. So that for our purposes, we have to assume that you correctly transposed from the original report each of the various figures that appears here?

A. Yes. And I have had a lot of practice.

Q. There were some typographical errors in your testimony that we've found already, but you believe that this does not have typographical errors?

A. Yes. Numbers are more important to me than letters.

Q. Aside from the four reactors listed here, do you know how many other reactors there are around the country?

A. I believe there are about 70 that are operating.

Q. Did you say, "About 70"?

A. Yes.

Q. And what names, for instance, would those reactors have? Do you know the names of any nuclear reactors around the country?

21-9

A. Oh, a few of them. Fort St. Vrain. There's a plant at Kenah, and there's Dresden I, II, II, and Millstone.

Q. Okay. I wanted to ask you first about Fort St. Vrain. Do you know who makes the reactor system -- the reactor vessel or the reactor cooling system for the turbine. Do you know the names of the manufacturers?

A. I don't recall who makes those components there. It's a special case.

Q. Do you know what companies are involved in the manufacture of components -- the large components of nuclear reactors?

A. Westinghouse, Combustion Engineering, Babcock and Wilcox, General Electric.

Q. Looking again at this table, do you know whether, for instance, column one which reads Westinghouse, would that be a figure that -- would all of the figures under the Westinghouse title be figures which represent the releases from all Westinghouse reactors around the country?

A. It was my belief this pertained to a single reactor of that type which has been monitored.

Q. And then would your answer be similar for Combustion Engineering, Babcock and Wilcox and General Electric BWR's, that they --

21-10

A. Yes, as I recall.

Q. -- that these numbers represent some particular plant manufactured by and identified by manufacturer?

A. I thought so, yes.

Q. Do you know which reactors those are?

A. No,without referring to in the original report, but I can send that to you.

Q. Do you know what type of plant the Waterford 3 plant is?

A. Pressurized water reactor, I think made by Combustion Engineering. Is that correct?

Q. Well, let me ask you. Is that your best understanding of the situation?

A. Yes.

Q. Do you know whether Combustion Engineering has more than one type of reactor design?

A. I don't know.

Q. Do you know whether the effluent treatment systems for Combustion Engineering reactors are uniformly the same for all Combustion Engineering reactors?

A. I don't know.

Q. If you look to the figure under Combustion Engineering for neptunium 239, as represented in your table, what is the number that appears there?

21-11

A. That's 10 million.

Q. Ten million picocuries?

A. Yes.

Q. Do you know how many picocuries of neptunium 239 have been estimated by the NRC Staff as likely possibly to be in the release from Waterford 3?

A. Well, there were two numbers: Three millicuries, and I think the corrected one was about one-thousandth of that, roughly.

- - -

22-1 ge

Q. In terms of picocuries, can you translate that for me?

A. Yes. One would be three billion picocuries -- which then was reduced to three billion picocuries.

Q. I'm not sure that your calculation is correct. Do you want to take a moment?

A. I don't have it on the table in front of me. I'm just trying to recall the numbers from memory.

Q. I'm going to show you a table which appears in Staff Exhibit No. 1, which is the Staff's Final Environmental Statement for the Waterford 3 plant, and ask if you can identify the predicted or likely or possible release figure for Neptunium-239?

(Document handed to witness.)

MR. TURK: For the record, I am now showing the witness Staff Exhibit No. 1, Table J-8, and I point to the Neptunium-239 release, which bears a corrected notation of 0.00003, and the table gives figures in curies per year.

BY MR. TURK:

Q. Am I correct?

A. Yes.

Q. How would you translate that number into picocuries?

A. The corrected figure, 0.00003 curies per

22-2

year, I would translate to be 30 million picocuries.

Q. So that this table would reflect that the Staff has calculated that Neptunium-239 will be three times greater than that which is found in the table which you prepared?

A. That's correct, for this plant.

Q. Do you have any evidence to bring before this Licensing Board which would indicate that the figure which represents the Staff's neptunium release calculation is other than the figure which we have just identified?

A. Only the comparison with the release from the Oyster Creek plant which shows the figure about 20,000 times larger.

Q. Do you know what type of plant the Oyster Creek plant is?

A. It's a boiling water reactor.

Q. Do you know the name of the manufacturer of that plant?

A. I don't recall.

Q. Do you recall the name of the manufacturer of the effluent treatment system for that plant?

A. No.

Q. Do you know whether the effluent treatment system for Oyster Creek was manufactured by the same company that manufactured the one for Waterford 3?

22-3

A. No.

Q. Do you know if there's any similarity whatsoever between effluent treatment systems for the two plants?

A. No, I do not.

Q. You do recognize, don't you, that if we look across the table for Neptunium-239, we'll find that the figure for Westinghouse reads 3,200,000; the figure for Combustion Engineering reads 10 million; the figure for Babcock & Wilcox reads 20 million; and the figure for the GE boiling water reactor reads 8,600,000?

A. Yes.

Q. That would indicate to you that at least as between these plants, if these figures are correct, that someone has calculated that there will be a different emission rate or a different release rate by release amounts of Neptunium-239 from these various systems; is that correct?

A. You could imply that.

Q. In other words, whoever did the calculations from which you drew your data apparently had concluded that there will not be uniform amounts of release for the various plants which are represented on this table; is that correct?

A. That's correct, yes.

22-4

Q. You testified in your prior cross-examination testimony that you believe the area near the Waterford 3 plant can be characterized as being humid, as having a high water table, as being near an important river, and as being in an area affected by hurricanes.

Do you know whether the NRC Staff has considered those factors?

A. I believe they have.

Q. Do you believe that those factors have been considered in their dose calculations?

A. I don't know about that.

Q. Do you know whether ground water has a tendency or is characterized by a movement in one or another direction?

A. Yes.

Q. Do you know which way the ground water moves in the area near Waterford 3?

A. No, I don't.

Q. Do you know whether it leads to the river or away from the river?

A. I'm certain some of it does lead to the river.

Q. Is that based on any personal knowledge of the Waterford 3 plant site?

A. Not on personal knowledge.

Q. Are you a hydrologist by training?

22-5

A. No.

Q. Do you have any expert knowledge as to the character of groundwater movement?

A. No.

Q. You refer to two tests -- excuse me, perhaps that's my characterization.

You refer to two studies concerning Costa Carillo in South India and another in Brazil. Do you know who conducted the tests that you refer to?

A. Well, this is from memory. I have the references at home.

It seems to me that one of the workers was Cocopulley, and the other I don't recall but I can provide for you tomorrow.

Q. How did the persons who conducted the tests happen to choose those two areas to do their studies?

A. They were known to have high background radiation.

Q. Do you know what the source of that background radiation was?

A. I think that thorium sands; one area had a good bit of thorium in the sands, and I've forgotten what was the prevalent natural isotope in the other.

But it was based on estimated external radiation exposures.

22-6

Q In your response to Question No. 6 in your written testimony, on the second page of your response, at the top of the page, beginning, "The results of this study," towards the end of that paragraph you refer to a grant by the National Radiation Research Foundation.

Is that the correct name of the organization to which you are referring?

A That's one of two grants I have. That is the correct name.

Q Can you tell me anything about that organization? Do you know whether it's been formed under the auspices of some other group?

A I don't know whether it has or not. It's based in Washington.

Q Is it a government agency?

A No, I believe it's a private -- a private foundation. I guess it's private.

Q Is it associated with any known group which has taken a position one way or another on atomic power?

A I don't know.

Q Can you identify the director of the organization?

A Let's see. I've written some correspondence to him. I don't recall his name.

It may have been Brown. No, it's not Brown.

22-7

I don't do well with personal names.

I can't tell you who directs NCI either, or NIH.

Q. How did you happen to hear of them?

A. I learned of this foundation through Stewart Udall.

Q. And can I ask what you learned about the organization from him?

A. He suggested that the group might be willing to support a study of cancer in Utah.

Q. And why would he have felt that they might be willing to do that?

A. I presume he knew something about the foundation.

Q. But you don't know what knowledge he had of the organization? He didn't communicate any knowledge to you?

A. No, I don't.

Q. Is it a public interest group?

A. What is a public interest group?

Q. As you understand the term.

A. It's a foundation. That's really all I know about it.

Q. Would you happen to recall their street address?

22-8

A. No. I have it, but I don't remember addresses.

Q. Can you recall anything else about the organization?

A. No.

Q. How much of a fund or a grant have they provided you with?

A. $15,000, a very large sum.

Q. Do you think they know more about you than you know about them?

MR. JONES: Objection, Your Honor. I don't see the relevance or materiality of that.

MR. TURK: I withdraw the question.

THE WITNESS: That's all I asked for. I might have asked for $4 million like the University of Utah did.

BY MR. TURK:

Q. Do you understand the term LET?

A. Well, I've understood it to stand for linear energy transfer in the sense of some radiation having high linear energy transfer and others low.

Q. Do you know whether there is a different health effect associated with high LET vis-a-vis low LET radioactive particles or radionuclides?

A. Well, alpha radiation is considered to have a high linear energy transfer, has a greater effect than radiation which has a low transfer of energy linearly.

BY MR. TURK:

Q. In response to Question No. 11 of your written testimony, you discuss the report by Lyndon, Archer and Wagoner. And I see that that involves a study of lung cancer in uranium miners and asbestos workers.

Do you know whether uranium is a high LET or low LET element?

A. Yes. Uranium emits some irridation and will transfer quite a bit of radiation linearly.

Q. How about radon?

A. Well, in the chain some emit beta, which is not high LET, not nearly as high as alpha. Radon daughters includes a number of alpha emitters.

THE REPORTER: I'm sorry, Doctor. Includes what?

THE WITNESS: Includes a number of alpha radiation emitters.

Delta radiation is associated with a large amount of transfer -- a large transfer of energy. Beta and gamma is not.

BY MR. TURK:

Q. If a person was working in a uranium mine, would he be exposed to a lot of high LET radiation?

A. Yes.

Q. And do you know whether he would be receiving

23-2

a dose which would be greater than the comparable dose he would have received had he been exposed to low LET radiation?

A. Well, the dose, you see, considers both; high LET and low LET radiation can consider both, but you must also consider the amount of time and the amount of dose, yes.

You can get a large dose from low LET radiation.

Q. But that would take a greater quantity?

A. Yes.

Q. -- of element exposure?

A. Correct.

Q. -- of radioisotopic exposure?

A. Correct.

Q. -- than you would get from a dose of high LET?

A. Yes.

The one rad of gamma gives out about one rem of dose. One rad of alpha radiation gives about 20 rems of dose. There's your high and low LET radiation.

But you can get a lot of rads from either source, if it's a large source -- a lot of rem from either source, I mean.

Q. Turning to your response to Question 13 on

the -- in the last paragraph of the first page of your response to Question 13, you're speaking here of the BEIR Committee Report. And I believe you identify that you're speaking about BEIR Committee Report No. 1. Is that correct?

A. II.

Q. II?

Is it your testimony that in the BEIR II Report, there is a statement that 170 millirems per year will result in an increase in the amount of ill health due to injury related to chromosome damage eventually in five percent of the population?

A. As it states here, these are their estimates which I think they've taken from the Federal Radiation Council.

Q. Do you know whether the BEIR Report indicated that these will be the effects, or that these may be the effects?

A. They say these are estimates.

Q. Do they provide a range in their estimating effects?

A. As I recall, these are the figures in the summary statement in the front part of that report.

If you have it here, I can find it for you.

Q. Well, let me see if I can test your

23-4

knowledge. Do you recall whether they indicated in this report whether there is a range of effects which could range from zero effects up to some higher stated number?

A. In the summary statement, I think -- I don't believe they do.

Q. So you're only familiar with the summary statement?

A. No, I have read the report itself. But I refer to the summary statement quite often because it seems to be a sort of baseline figure.

Any estimate certainly could carry a range, and it usually does.

Q. But you don't recall what the range was that was stated in the BEIR Report?

A. No, I don't.

Q. Is your evaluation of the effects which might be anticipated for the Waterford 3 plant based on your understanding of the BEIR Report as set forth in this paragraph?

A. I used these figures to -- on which to get some idea as to what effects you might expect from a certain dose. To that extent it's important.

Q. So you believe that the BEIR Report to which you referred stated that from the dose of 170 millirems, you get these effects as contained in this paragraph; and

23-5

you have more or less extrapolated downwards?

A. I didn't get into dose estimates for the Waterford reactor.

Q. So you did not do any extrapolation?

A. Not from the data given in the report from the Waterford reactor.

Q. Did you do any extrapolation from the figures which you represent here as having been contained in the BEIR Report?

A. No.

Q. And that's true as to each of the different figures that are contained in this paragraph? The -- what you represent as an increase of .75 percent increase in birth defects and diseases related to chromosome injury, as well as a two percent increase in spontaneous cancer death rate, you didn't do any extrapolation of those figures then, too?

A. I extrapolated the figure for increased incidence of non-fatal cancers. The report gave only the two percent increase in spontaneous cancer death rate. Since roughly half of cancers don't go on to death, I extrapolated the two percent increase in non-fatal cancers.

That's my figure. In addition, there is a similar number of benign tumors, which are induced by

radiation. It's usually taken to be about a one-to-one ratio.

The study of the survivors of Hiroshima/Nagasaki shows, in fact, you could have a larger number of benign tumors compared to malignant tumors in persons exposed to cancer.

JUDGE FOREMAN: Exposed to radiation?

THE WITNESS: Pardon me. Exposed to ionizing radiation.

In the mid-range doses, I think 10 to 99 rads, there were nearly twice as many benign tumors induced in proportion to the cancers induced in children under ten.

At the low doses and higher doses, it was more of an even ratio, as I recall.

BY MR. TURK:

Q Doctor, are you familiar with the term DNA?

A Yes.

Q Can you give us a definition or -- Let's start with identifying what that acronym stands for.

A Dioxynucloid -- ribinucloidic acid. It's important in carrying genetic information to make this other cell.

Q Do you know whether there's any repair process associated with DNA?

23-7

A. Yes. There's some repair process associated with it.

But I think it's poorly understood and probably still an area of some controversy.

Q. To your knowledge, are there any studies which look at the repair mechanism in terms of the ability of a cell to repair genetic damage, which may have been incurred as a result of radiation?

A. I think there have been some studies.

Q. Are you aware of any in particular?

A. No. I haven't given much weight to those, because I would rather look at the more empirical studies which look at the populations exposed to certain amounts of radiation, and then observing what has happened to them after exposure.

This to me has more meaning in relation to radiation exposures than do laboratory studies of DNA repair.

Q. And you're probably not familiar with the conclusions of any of the studies?

A. No.

Q. -- of which you're generally aware?

A. That's correct.

Q. Do you know whether a cell in human tissue has the ability to repair genetic damage incurred by

23-8

any particular dose of radiation, let's say, one nanorem?

A. I think that there is a view that there is a limited capacity to repair injury of that sort.

Q. But that's the extent of your knowledge?

A. Yes.

Q. Are you aware of any studies which show a synergism between radiation and any chemicals which might be present in the atmosphere or water in Louisiana?

A. In Louisiana?

Q. Yes.

A. None for that narrow focus.

Q. I believe you've testified already that you weren't aware of any particular chemical concentrations in Louisiana, either in the air or in the --

A. To the contrary. I believe I testified that I was aware of such a study, and I turned to a table, and I was prepared to read the concentrations off for water in Louisiana.

Would you like to hear those?

Q. I'm not sure I understand you. Do you, of your own knowledge, know of the chemical concentrations present in the air or water in Louisiana?

A. Only articles I've read. I haven't done work myself in this area.

Q. Doctor, I believe you testified that you were

not familiar with Reg Guide 1.109?

A. That's correct.

Q. And from that can I conclude that you're not aware of any particular transport models which may be found in Reg Guide 1.109?

A. That's correct. That is not -- as contained in that Guide.

Q. Or any other transport models which may be used by the NRC Staff in calculating doses?

A. Well, I understand some of the points considered by the transport models.

Q. But you're not aware of the models themselves which may be used?

A. No, I haven't studied the models.

MR. TURK: I have no further cross-examination.

JUDGE WOLFE: Redirect, Mr. Jones.

MR. JONES: Your Honor, might I request that we take a 15-minute recess at this time? I perceive that I will only have about half an hour of redirect examination.

JUDGE WOLFE: All right. We'll recess until a quarter of 5:00.

MR. JONES: Thank you, Your Honor.

(A short recess was taken.)

24-1 ge

JUDGE WOLFE: All right, Mr. Jones.

MR. JONES: Thank you, Your Honor.

REDIRECT EXAMINATION

BY MR. JONES:

Q Dr. Johnson, as you will recall, this morning before the lunchtime recess Mr. Blake asked you several questions with respect to the views you express in Question 21 regarding the appropriate agencies of the Federal Government with respect to providing adequate protection for public health in the area of low-level radiation exposures.

My first question in this regard is whether you can explain to the Board the basis for the views which you have expressed in your direct testimony?

A Well, yes. As a health officer in Jefferson County, Colorado, I had a great deal to do with health risks from a nuclear plant and Department of Energy facility, and it seemed to me that the radiation protection guides by this agency and by the NRC were not sufficiently protective of the public, and in my view did not reflect a concern for public health, at least as a priority matter.

One example is the uranium concentration in drinking water, a water district contaminated by a uranium mine.

24-2

There was concern about high levels of radiation from uranium, and we found there really was no official standard providing protection to the public. An operating one set a limit of 6,000 picocuries per liter for chronic ingestion of drinking water.

The calculated radiation dosages, these are far too high, and earlier limits were even higher than that.

There is now an EPA position which states that limits should be no more than ten; not six thousand, but ten.

We have two advisory letters from the EPA which defend that concentration guide.

Then there's the matter of tritium. The Atomic Energy Commission and later ERDA and I think NRC, too, permitted one million picocuries of tritium per liter of drinking water.

This was a matter of importance in my district where one community drinks water contaminated by the Rocky Flats nuclear plant.

The limit for that isotope is now 20,000, a reduction by fifty-fold.

There's a limit for plutonium, unofficial -- it isn't official limit -- of 1600 picocuries per liter; but some experts like Carl Morgan think this is about

24-3

10,000 times too high to be protective to the public.

Q. Thank you, Dr. Johnson.

In your experience as a public health official, have estimated release rates from those installations which you have studied been accurately -- strike that. Let me rephrase the question.

Have the actual release rates with which you are familiar been the same or similar to any estimated release rates with which -- which may have been asserted by the plant operators?

A. There have been large discrepancies. At a public meeting in the Denver area in 1979 a representative of the Rocky Flats nuclear plant said that their air samples, their monitors, showed plutonium levels in the air to be about the same as the world-wide weapons fallout.

At the same time I had a report from the Environmental Measurements Laboratory in New York, which listed readings for plutonium contamination at 51 air sampling stations throughout the Western Hemisphere.

Two of those stations were around the Rocky Flats plant, but managed by Environmental Measurements Laboratory in New York.

Their report showed the levels at Rocky Flats to be the highest in the Western Hemisphere every month measured; and for the full year of 1977 the average

24-4

concentration was 1,300-and-some times higher than the reading for the full year at the low station in this hemispheric-wide network.

No way were levels near fallout.

Earlier reports from the plant released in discovery proceedings against the plant showed that it was known to officials at the plant that their monitoring system was not accurately reflecting the actual contamination in the air.

Q. Dr. Johnson, does this experience conform to other nuclear installations with which you are familiar?

A. Yes. I had a conversation with the health physicist hired by the County Board of Supervisors of Ocean County, New Jersey, who had bought new instruments to monitor radiation around the Oyster Creek nuclear powerplant.

He told me that he had found high levels of radiation around the plant and had taken this information to health physicists for the State Health Department, who told him his instruments couldn't be correct because this plant didn't release anything of importance.

He then went to the NRC who told him the same story, that, "Your instruments must not be calibrated correctly, because we don't find anything being released."

The health physicist in the county had never heard of the EPA report and he had some trouble getting it,

24-5

so I Xeroxed the entire book and sent it to him.

That's another example.

Q. Dr. Johnson, you have earlier indicated your familiarity with the concept of synergy.

Do you find that those studies which deal with synergistic interactions between radiation and chemical materials, particularly chemical carcinogens, accurately depict the physical phenomenon of synergy?

A. Yes. This idea -- the concept is well accepted. There have been studies, for example, of smog and Etna Virus II, smoking, Etna Virus II effects on animals.

There's a synergistic effect, and we mentioned earlier studies of radiation and chemical carcinogens.

Q. Do you find that the radiation/chemical interaction studies provide a model for the idea of interactions between low levels of chemical carcinogens and low levels of radiation, such as those which you have experienced to be releases from nuclear facilities?

A. Yes. I think this is a very acceptable model. Carcinogens are used in large doses, along with small doses, to induce cancer in animals, to demonstrate their carcinogenicity.

Radiation is used in high doses and from that,

25-6

using the linear hypothesis, you can estimate numbers of low doses.

You can demonstrate synergy in these studies between radiation and chemical carcinogens. You can make estimates of effects of very low doses in large populations and in people who live much longer than do animals and so have more opportunity to express development of cancer from low doses.

Q Based on your experience -- strike that.

Can you tell the Board, Dr. Johnson, what environmental chemicals might interact with Waterford 3's radiation to give rise to synergistic effects?

MR. TURK: Objection to the question as being outside the scope of cross.

MR. JONES: Your Honor, I believe that the matter of -- the question of specific organic chemicals was raised both by Mr. Blake and by Mr. Turk.

The witness has said he was generally aware of organic chemicals in Louisiana or potential carcinogens in Louisiana, and I'm merely asking him to clarify the point.

JUDGE WOLFE: The point that you seek clarification of is what?

MR. JONES: If he can advise the Board as to any specific organic chemicals which are found in the

25-7

Louisiana environment which would become part of a synergistic reaction, or a synergistic interaction.

JUDGE WOLFE: And you say this is outside the cross-examination, Mr. Turk?

MR. TURK: Yes. The witness was asked during cross-examination whether he was aware of his own knowledge what chemicals were present in Louisiana and what concentrations.

He said he was not. Now what I believe is about to happen is that direct testimony is about to be expanded beyond that which the witness has testified to in his prior direct or in cross.

I think this is an attempt to put in supplemental direct through a back-door route.

Incidentally -- well, I would have to wait and see what it is that the witness is about to refer to. I see that he has some papers spread out in front of him now.

JUDGE WOLFE: Any input, Mr. Blake?

MR. BLAKE: No. Only that I would have to quarrel with Mr. Jones' reference that I used the term "organic chemicals."

I'm confident that the record will reflect that I never have used that term during the course of my cross.

25-1
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MR. JONES: With the Board's permission, I'd like to withdraw the question and rephrase it.

JUDGE WOLFE: All right.

BY MR. JONES:

Q Dr. Johnson, can you tell the Board whether in your opinion the substances known as aromatic hydrogenated hydrocarbons could interact with radiation to cause synergistic effects?

MR. TURK: Objection. That's not within cross-examination.

I think -- The point which I'm trying to make is that -- we've all had an opportunity to present direct testimony and direct evidence. That evidence was submitted as required by the rules several weeks ago. We've prepared cross-examination based on that evidence --

JUDGE WOLFE: Is there anything in your direct examination that's directed toward this matter and/or can you point out where the witness said that he is aware of such -- and taken these matters into consideration in considering synergism?

MR. JONES: Just a moment, please, Your Honor.

(Pause.)

MR. JONES: Your Honor, I would like to call

the Board's attention to Question No. 20. It states: "What special risks is Louisiana exposed to as a result of high levels of chemical contamination in combination with routine emissions of radiation from Waterford 3?"

The answer is: "We could expect to see a synergistic effect in Louisiana where people may be exposed to high levels of chemical contamination in the water, along with normal exposure to radionuclides from nuclear plants, in the air, water or food."

JUDGE WOLFE: Well, there is a general allusion to high levels of chemical contamination. True, that's in the question; and true, it's responded to.

But it's the Board's recollection that when, I think -- possibly this particular question was being cross-examined upon, that the witness said that he had no knowledge of the nature, types, whatever, of chemical effluents in this area.

That settles it. If he had no knowledge then, it would seem to me that this settles it. Can you explain why the witness said he had no knowledge and now has knowledge?

THE WITNESS: It's impossible to address.

MR. JONES: Your Honor, my recollection of the colloquy this morning between Mr. Blake and the witness was that the witness' statement was that he had no

current recollection of specific chemicals. He stated that he had read papers with respect to the environmental pollutants in the Southeastern Louisiana area.

I'm merely trying to get a clarification on that point.

MR. TURK: May I respond very briefly?

(Bench conference.)

MR. TURK: Mr. Chairman --

JUDGE WOLFE: Yes.

MR. TURK: As I recall the colloquy, the witness was asked whether he had personal knowledge, or something to that effect, of the chemical concentrations or elements; and his answer was no, he thinks reports have been published.

He identified one in particular. He was asked whether he had seen that one prior to filing his written testimony. He said no, he saw it afterwards. He saw it only last week for the first time.

I think this is a clear attempt to go beyond what is in the direct testimony and what was intended in the direct testimony by the author of it.

JUDGE WOLFE: Yes, that's correct. I'm going to sustain the objection, Mr. Jones.

BY MR. JONES:

Q Dr. Johnson, you have stated in your testimony

that you find the research of Dr. Ashekawa, who has studied the variant spiderwort plant, to be acceptable evidence of radiation releases which are substantially higher than the releases reported by plant operators.

Can you tell us what is the basis for your view that it is appropriate to utilize biological monitors to check upon the emissions from nuclear power plants?

A. It's a well accepted concept in medicine that you can use biological monitors. For example, a chemist in a pharmaceutical laboratory may concoct a new chemical analog of a drug, which he calculates will be more effective and have fewer side effects.

Then he must find some biological monitors to test this against, and use experimental animals, do biological studies, and finally you have a clinical study of population, which is in itself a biological monitor.

It also is a fairly old concept. Some years ago when we knew there were vitamins and hormones, these had to be evaluated against biological monitors. We talked about mouse units and frog units.

This is an empirical way of seeing what actually is being done to a biological organism. In the case of nuclear power plant emissions, we know there are several hundred different types of radionuclides released,

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many of which would have some biological activity, take part in metabolism or be handled in certain ways in various organs of the body. Like radium and thorium, for example, they're concentrated by about 29 times in one cell type -- the molatocyte -- more than other cells 29 times.

Further, the monitoring of nuclear power plant emissions is incomplete. The several hundred radionuclides are not all monitored. It may be 10, 20 or 30 which are measured.

And as you heard this morning, there may be only four measurements taken in a year. Who knows what was released on Monday when you're sampling on Tuesday?

A plant -- a biological monitor, like the plant, is there 24 hours a day, seven days a week and may register effects which are undetected and unreported by the people who own and operate the plant.

Q. What was the nature of the findings and conclusions of the study of the -- I believe you called it the Vial plant in West Germany, which was conducted by the Heidelberg Institute?

A. The Heidelberg Institute was contracted to do an evaluation of a proposal to build a nuclear power plant near the village of Vial. As I recall, the official German nuclear agency's risk estimates showed a very low

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dosage, on the order of a few millirems per year, to the people living in the area.

The biologists with the Heidelberg Institute did a study, reviewing all of the assumptions which had been made and taking a more conservative viewpoint of risks and came up with estimated dosages of about one rem per year.

On the basis of their report, the West German Government decided not to build the Vial reactor.

The assumptions which were challenged by a Heidelberg group included the use of experiments, and all assumptions should have some external basis -- the experiments in which soil was cooked and all micro-organisms destroyed in the soil.

Actually, the flora and fauna -- the micro-flora and fauna of the soil are part of the soil. If you cook it, it's no longer soil in the same sense.

And with normal soil, you get a much higher rate of uptake.

And further, you've got to consider the conversion in the food chain, the -- certain radionuclides into organic compounds, like vitamin $B_{12}$ with cobalt 60 in the middle, which are taken up much more avidly by persons and by cells within the bodies of persons, than you would estimate from doing studies with the organic

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on radiocobalt.

I felt their approach was much more sound than the older approach, which I understand characterizes the NRC approach, and the English and German counterparts.

Q. Is it your view then, Doctor, that the methodology of the Heidelberg study is preferable as a means of determining risk estimates?

A. Yes, I did feel so.

Q. Doctor, based upon your experience as a public health professional, what is your estimate as to the cumulative and synergistic public health risks which faces the population of Southeastern Louisiana from proposed radionuclide emissions of the Waterford 3 plant?

A. It's my view that they're unacceptable in view of the current risk to health from the number -- fairly large number of carcinogens in drinking water and from higher cancer incidence rates already present here, that the imposition of an additional burden of a carcinogen -- actually several hundred carcinogens released by the plant, even though initially in low concentrations, that this would not be acceptable.

I think further down the line there are much more serious risks to contend with, the risk of --

like at the pressurized light water reactor in Maine, large releases of radioiodines or accidents -- unanticipated releases of radioiodines and other radionuclides, that I would be opposed to having the plant in this area.

MR. JONES: Thank you, Dr. Johnson; that's all the questions I have.

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JUDGE WOLFE: Proceed to Board questions.

JUDGE FOREMAN: Someday when I become czar of the hearing process, I'm going to rearrange things so that the Board questions don't come at the end of the day when everybody is tired and wish to the devil that we wouldn't ask questions.

I'm only going to ask a couple.

BOARD EXAMINATION

BY JUDGE FOREMAN:

Q. First of all, with respect to those two studies in the high background areas in Carillo and in Brazil, you don't recall the names of the people who did the study or know who did the study or under whose auspices they were, do you?

A. Yes, sir. I have the reports in my office. I can get them in the mail tomorrow to you, both reports.

Q. Well, I want to ask you a question --

A. Cocopulley was one.

Q. Pardon?

A. Cocopulley.

Q. I see. Well, I want to ask you some questions about your opinion, as an epidemiologist as to their validity.

I'm sure you are aware that there must be a very large number of compounding factors involved in

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trying to estimate health risks in relation to any insult in those particular areas.

Had you looked at those studies well enough that from your viewpoint as an epidemiologist that you consider those findings valid and good?

A. The first study looked only at the rate of chromosome aberrations. There was a control population in the same area.

It seemed to me that the evidence from one report is certainly suggestive.

The two reports are cited together because two reports are certainly stronger than one when they show similar results.

When you look at birth defects of genetic origin, you are always looking to the age of the mother. I don't recall now if that was considered or not.

But it seemed to me that the evidence with chromosome aberration rates was pretty strong; and, also, in looking at the two studies together, there appeared to be a crude dose/effect relationship.

Q. Okay, thank you.

The second area that I'd like to explore with you is the area of synergism between the chemical carcinogens and ionizing radiation.

Was I correct in hearing you say that it's

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your opinion that in the consideration of synergism between carcinogens and ionizing radiation, that it's your opinion there is a linear relationship between dose and effect?

A. I was trying to show that it is possible to make some assumptions about that, about the synergistic effect of ionizing radiation at low doses when the animal studies had used high doses.

We know in the first place that extremely small amounts of carcinogens can induce cancer. The question is, the work with animals was done with high doses; would low doses have a similar effect, proportionately lower according to dose?

It's my opinion that there's no reason why it shouldn't.

Q. But you know of no studies or have any evidence that would support that, or do you?

A. No studies of that type because that study will be very expensive.

With low dose radiation you need large numbers of animals and a long time to maintain those animals.

Q. In your knowledge of the literature, what were the lowest doses of ionizing radiation that were used in conjunction with chemicals that produced a synergistic effect?

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A. The study I happen to have today mentioned the high dose. I found it earlier.

The doses have been rather high in such studies.

Q. And have you seen studies wherein a range of doses of ionizing radiation were used in an attempt to determine the dose effect, the dose rate effect or just the dose effect?

A. I think there is such a study, though I don't have it with me. I'd have to make a search for it at home.

Q. Have you seen any studies in which the doses were varied and there were doses of ionizing radiation in which there was no synergism; in other words, at the low doses?

In your experience, have you ever seen those studies?

A. No, I haven't.

Q. Is this because you are not thoroughly familiar with the literature, or do you feel that you know enough about the literature that there are no such studies?

A. I have made a pretty thorough search, computer search, but I don't recall having seen that report. If there is such a report, I'd like to see it.

JUDGE FOREMAN: Okay. Thank you.

JUDGE WOLFE: Cross on Board questions,

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Mr. Blake?

MR. BLAKE: Not on the Board questions, but I have some recross on Mr. Jones' redirect.

(Bench conference.)

JUDGE WOLFE: I'm sorry, Mr. Blake. What do you want to do now?

MR. BLAKE: What was this?

JUDGE WOLFE: I asked you if there were any cross-examination on the Board questions.

You have finished, have you not?

JUDGE FOREMAN: Yes.

JUDGE WOLFE: Do you have any questions?

You want to recross; is that what you want to do?

MR. BLAKE: I said not on the Board questions, but that I had one area of recross, based on Mr. Jones' redirect.

JUDGE WOLFE: I wish you had told me that sooner before we had gotten into Board questions.

All right, go ahead.

Is there something wrong, Mr. Blake?

MR. BLAKE: No, sir. Well, I guess what you are referring to is I actually leaned up to look for recross and then you never asked whether or not there was any.

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Actually, the same thing happened yesterday.

JUDGE WOLFE: Counsel have to be quick.

(Laughter.)

JUDGE WOLFE: All right, you are recognized for recross.

RECROSS-EXAMINATION

BY MR. BLAKE:

Q. Dr. Johnson, your attorney, Mr. Jones, has asked you on redirect about an experience that -- or at least a question which led you to relate an experience involving an Ocean County health physicist, a subject which I had not heard either in direct or in the course of cross-examination.

When did this experience occur?

A. It was, I believe, in 1978.

Q. Do you know the name of this health physicist from Ocean County?

A. I'm trying to recall his name now. There's only one.

Q. Do you know what his qualifications are?

A. I know he's a health physicist. That's all I know about him.

Q. Do you know what kind of equipment he used to detect or measure releases from the Oyster Creek plant?

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A. This would be a beta gamma survey meter. I don't know what else he had.

Q. Do you know what levels he saw?

A. No, I don't recall now what levels were -- they were high at times.

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Q. Do you know what levels were being reported, either by the utility or being evaluated by the NRC at that point in time?

A. I have only this person's testimony, his conversation with me on the phone.

Q. Do you know whether or not the State of New Jersey itself was measuring the levels of releases from the Oyster Creek plant during the same period of time?

A. No.

Q. Do you know what the outcome was?

A. No, I don't know the outcome. I think I did see him later --

Q. That's sufficient, Dr. Johnson. Thank you.

MR. BLAKE: No more.

JUDGE WOLFE: No quick re-re?

MR. JONES: Nothing further, Your Honor, from Joint Intervenors.

JUDGE WOLFE: Nothing further from the Board.

Are you going to be quick on recross?

MR. TURK: I don't know if there's any point in being quick. I only wanted to state that I have no recross.

JUDGE WOLFE: Is the witness to be excused permanently?

MR. JONES: We would move that the witness

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be permanently excused, Your Honor.

JUDGE WOLFE: The witness is permanently excused.

(The witness was excused.)

JUDGE WOLFE: After we recess, we'll have a chat about tomorrow's schedule and see how we'll proceed.

We do stand in recess until 9:00 a.m.

(Whereupon, at 5:35 p.m., the hearing was adjourned, to reconvene at 9:00 a.m., Friday, April 2, 1982.)

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NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

in the matter of: LOUISIANA POWER & LIGHT COMPANY (WATERFORD)

Date of Proceeding: April 1, 1982

Docket Number: 50-382-OL

Place of Proceeding: New Orleans, Louisiana

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Mary L. Bagby

Official Reporter (Typed)

Mary L. Bagby

Official Reporter (Signature)