ORIGINAL

OFFICIAL TRANSCRIPT
PROCEEDINGS BEFORE

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

DKT/CASE NO. 50-247 SP and 50-286 SP

TITLE CONSOLIDATED EDISON COMPANY OF NEW YORK (Indian Point Unit 2) - POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point Unit 3)

PLACE White Plains, New York

DATE February 18, 1983

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

- -x

In the Matter of:	:	Docket Nos.:
CONSOLIDATED EDISON COMPANY OF NEW YORK (Indian Point Unit 2)	:	50-247 SP
POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point Unit 3)	:	50-286 SP

- -x

Ceremonial Courtroom
Westchester County
Courthouse
111 Grove Street
White Plains, N.Y.

Friday, February 18, 1983

The hearing in the above-entitled matter convened, pursuant to notice, at 9:10 a.m.

BEFORE:

JAMES GLEASON, Chairman
Administrative Judge

OSCAR H. PARIS
Administrative Judge

FREDERICK J. SHON
Administrative Judge

APPEARANCES:

On behalf of Licensee, Consolidated Edison Company of New York:

BRENT L. BRANDENBURG, Esq.
Assistant General Counsel
STEVEN SOHINKI, Esq.
Consolidated Edison Company of New York, Inc.
4 Irving Place
New York, N.Y. 10003

On behalf of Licensee, the Power Authority of the State of New York:

JOSEPH J. LEVIN, Esq.
PAUL A. COLARULLI, Esq.
Morgan Associates, Chartered
1899 L Street, N.W.
Washington, D.C. 20036

On behalf of the Nuclear Regulatory Commission Staff:

JANICE MOORE, Esq.
HENRY J. McGURREN, Esq.
Washington, D.C.

On behalf of the Intervenors:

Council of the City of New York:

CRAIG KAPLAN, Esq.

Friends of the Earth, Inc., and New York City Audobon Society:

RICHARD HARTZMAN, Esq.

New York Public Interest Research Group:

JOAN HOLT, Esq.

APPEARANCES: (Continued)

On behalf of Intervenors:

Union of Concerned Scientists:

JEFFREY BLUM, Esq.
STEVEN SHOLLY

West Branch Conservation Association:

ZIPPORAH S. FLEISHER
443 Buena Vista Road
New City, N.Y. 10956

C O N T E N T S

P R O C E E D I N G S

JUDGE GLEASON: If we could get started, please.

MS. MOORE: Mr. Chairman, first of all, the parties did agree last night to stipulate certain pieces of testimony into the record without cross-examination. We could do that now or we could do that when a contention is heard.

JUDGE GLEASON: Well, if the parties have agreed let's do it now.

MS. MOORE: the parties have agreed to stipulate into the record the testimony of John R. Sears of the NRC Staff on contention 1.1 under Commission question one, and the testimony of Joseph P. Joyce concerning Commission question one, contention 1.1, without cross-examination.

I ask that the testimony be admitted into evidence and bound into the record as though read.

JUDGE GLEASON: According to the stipulation, the evidence will be admitted into the record and bound in as if read.

(The documents referred to, the prepared testimony of Messrs. Sears and Joyce, received in evidence, follows:)

(V) #1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSOLIDATED EDISON COMPANY OF NEW YORK (Indian Point, Unit 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit 3)	)))))))	Docket Nos. 50-247-SP 50-286-SP

TESTIMONY OF JOHN R. SEARS OF THE NRC STAFF
ON CONTENTION 1.1 UNDER COMMISSION QUESTION 1

Q.1. State your name and position with the NRC.

A.1. John R. Sears. I am employed by the U.S. Nuclear Regulatory Commission (NRC) as a Senior Reactor Safety Engineer in the Emergency Preparedness Licensing Branch, Division of Emergency Preparedness, Office of Inspection and Enforcement.

Q.2. Have you prepared a statement of professional qualifications?

A.2. Yes. A copy of my statement of professional qualifications is attached to this testimony.

Q.3. State the nature of the responsibilities that you have had concerning Indian Point, Units 2 and 3.

A.3. I have been responsible for reviewing and evaluating the Emergency Plan for Indian Point Unit No. 2 and Unit 3 for conformance with the planning standards and requirements of 10 CFR Part 50, Appendix E to Part 50 and the evaluation criteria of NUREG-0654, FEMA-REP-1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants" (NUREG-0654). As part of my responsibilities in reviewing and evaluating the Emergency Plans for Indian Point Unit No. 2 and Unit No. 3, I am also responsible for addressing bases 1(a) of Contention 1.1 under Commission Question 1.

Q.4. What is the purpose of this testimony?

A.4. The purpose of this testimony is to address basis 1(a) of contention 1.1. My testimony will address the licensees' standard emergency classification and action level scheme, the basis of which include facility system and effluent parameters.

Q.5. Have the licensees established an emergency classification and emergency action level scheme? Explain.

A.5. Yes, Section 4 of both licensees' Emergency Plans and provisions of their Implementing Procedures describe the methods and techniques for assessment of each of the four classes of emergency, Notification of Unusual Event, Alert, Site Emergency and General Emergency. The tables of initiating conditions in the procedures specify measureable and observable conditions in the plant instrumentation readings which are the initiating conditions for declaring an emergency.

Q.6. What are the criteria for licensees emergency action levels schemes?

A.6 The criteria for the licensees' emergency action level schemes are set forth in NUREG-0654, II.D and Appendix 1.

Q.7. Do the licensees' emergency procedures show the instruments, parameters or equipment for establishing each emergency class? Explain.

A.7. Yes, the procedures show the instruments by their identification number, e.g. ARM R-10, or equipment by its operating mode, e.g. RHR pump not operating.

Q.8. Have you examined the licensees' radiological emergency plans to determine whether the plans identify the parameter values and equipment status for each emergency class? Explain.

A.8. Yes, the procedures identify specific values for specific instruments, e.g. ARM R-10 greater than 330 mr/hr, or status lights show RHR pumps not operating.

Q.9. Does the licensees' emergency action levels include initiating conditions that are consistent with Appendix I of NUREG-0654? Explain.

A.9. Yes, the emergency plan implementing procedures for both licensees list the conditions in NUREG-0654, Appendix 1 with the corresponding Indian Point 2 and 3 conditions. I have compared the lists and they are consistent.

Q.10. Do the initiating conditions established by the licensees for emergency action levels include the postulated accidents in the Final Safety Analysis Report (FSAR) for Indian Point, Units 2 and 3?

A.10. Yes, for each plant the postulated accidents analyzed in the Final Safety Analysis Report are encompassed within the emergency classification scheme.

Q.11. Do the licensees' emergency action level schemes account for lead times necessary to activate emergency response plans and implement protective action decisions? Explain.

A.11. Yes, the licensees' emergency action level schemes described in the answer to Question 5 account for lead time necessary to implement protective action decisions in that emergencies are declared on the basis of control room instrumentation readings rather than on the results of down wind surveys and consequently the emergency would be declared before there would be a release of radioactivity from the plant.

Q.12. Do the emergency classification and action level schemes established by the licensees meet the planning standard of 10 C.F.R. Section 50.47(b)(4) and the requirements of Appendix E, Section IV.B and C of 10 C.F.R. Part 50?

A.12. Yes, the licensees' emergency action level classificaiton system and procedures which I have examined meet the planning standard of 10 C.F.R. Section 50.47(b)(4) and the requirements of Appendix E.IV.B and C of the 10 C.F.R. Part 50.

JOHN R. SEARS

RESUME'

Prior to 1952, I was employed in field jobs in various aspects of mechanical engineering. In 1952, I joined Brookhaven National Laboratory as a Reactor Shift Supervisor on the Broo. .ven Graphite Reactor. While at Brookhaven, I completed a series of courses given by the Nuclear Engineering Department in nuclear engineering. These courses were patterned on the ORSORT programs. In 1956, I was appointed Project Engineer on the Brookhaven Medical Research Reactor. I was a member of the design group, participated in critical design experiments, wrote specifications, coauthored the hazards report, was responsible for field inspection and contractor liaison, trained operators and loaded and started up the reactor. About three months after start-up, in 1959, following the successful completion of proof tests and demonstration of the reactor in its design operating mode for boron capture therapy of brain cancer, I accepted a position as reactor inspector with the Division of Inspection, U. S. Atomic Energy Commission. In 1960, I transferred, as a reactor inpsector, to the newly-formed Division of Compliance. I was responsible for the inspection, for safety and compliance with license requirements, of the licensed reactors and the fuel fabrication and fuel processing plants. which use more than critical amounts of special nuclear material, in the Eastern United States.

In September 1968, I transferred to the Operational Safety Branch, Directorate of Licensing. My responsibility included development of appropriate guides for evaluatio of operational aspect of license applications and staff assistance in review of power reactor applicants submittals in the areas of Organization and Management.. Personnel Qualifications, Training Programs, Procedures and Administrative Control, Review and Audit, Start-up Testing Programs Industrial Security and Emergency Planning

The Branch was reorganized as the Industrial Security and Emergency Planning Branch in April 1974 to place increased emphasis and attention upon areas of physical security and emergency planning.

In 1976 I transferred to the Divison of Operating Reactors as the sole reviewer responsible for review of emergency planning for all the operating reactors in the United States.

New York City College, 1950 - Mechanical Engineering

Argonne International School of Reactor Technology, 1961 - Reactor Control Course

GE BWR System Design Course, 1972

Popo-U.S. Army, 1974 - Course in Industrial Defense and Disaster Planning

Instructor at DCPA , 1976, 1977 - Course in Emergency Planning

Director, 1962 - Reactor Program, Atoms for Peace Exhibit, Bangkok, Thailand

Director, 1966 - Atoms for Peace Exhibit, Utrecht, Holland

(V) #2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-247-SP
CONSOLIDATED EDISON COMPANY	)	50-286-SP
OF NEW YORK (Indian Point, Unit 2)	)	
	)	
POWER AUTHORITY OF THE STATE	)	
OF NEW YORK (Indian Point, Unit 3)	)	

DIRECT TESTIMONY OF JOSEPH P. JOYCE
CONCERNING COMMISSION QUESTION 1, CONTENTION 1.1

Q.1 Please state your name and your position with the NRC.

A.1 My name is Joseph P. Joyce. I am a Senior Engineer in the Instrumentation and Control Systems Branch (ICSB) of the Division of Systems Integration (DSI).

Q.2 Have you prepared a statement of professional qualifications?

A. Yes. A copy of this statement is attached to this testimony.

Q.3 What is the purpose of your testimony?

A.3 The purpose of my testimony is to respond to Contention 1.1 bases 1.b--"Licensees have failed to provide instrumentation in accordance with Regulatory Guide 1.97, Rev. 2, thus compromising their ability to adequately monitor the course of accidents at Indian Point Units 2 and 3."

Q.4 What is the purpose of Regulatory Guide 1.97, Rev.2?

A.4 The purpose of the Regulatory Guide 1.97 is to provide the minimum design criteria for permanently installed instrumentation used to provide the operator with information that may be necessary to perform his role in bringing the plant to and maintaining it in a safe condition following the accidents indentified in the Design Basis.

Q.5 What is the status of Regulatory Guide 1.97, Rev. 2 as contained n SECY-82-111?

A.5 The Commission considered the Staff's proposed requirements for emergency response capability (including requirements for post accident monitoring) contained in SECY-82-111, "Requirements for Emergency Response Capability" dated March 11, 1982. The Staff was informed of the Commissions approval of the issuance of supplement 1 (SECY-82-111) to NUREG-0737 in a memorandum from Samuel J. Chilk dated November 22, 1982. Also the Commission approved the draft 10 CFR 50.54(f) letter to operating reactor licensees and holders of construction permits, requesting them to furnish a proposed schedule, no later than April 15, 1983, for completing and implementing the items in supplement 1 to NUREG-0737-"Requirements for Emergency Response Capability" (Generic Letter No. 82-33) were sent to all Licensees.

Q.6 Is it necessary for Indian Point Units 2 and 3 or any other licensee, to demonstrate compliance with Regulatory Guide 1.97, Rev.2?

A.6 Yes. Indian Point Units 2 and 3 must demonstrate compliance to Regulatory Guide 1.97, Rev. 2 but, the implementation plan and schedules from the Licensee is not required until April 15, 1983. Schedules are discussed on Page 2 of the December 17, 1982 generic letter:

> "You will note that the enclosure does not specify a schedule for completing the requirements. It has become apparent, through discussions with owners' groups and individual licensees, that our previous schedules did not adequately consider the integration of these related activities. In recognition of this and the difficulty in implementing generic deadlines, the Commission has adopted a plan to establish realistic plant-specific schedules that take into account the unique aspects of the work at each plant. By this plan, each Licensee is to develop and submit its own plant-specific schedule which will be reviewed by the assigned NRC Project Manager. The NRC Project Manager and Licensee willa reach an agreement on the final schedule and in this manner provide for prompt implementation of these important improvements while optimizing the use of utility and NRC resources."

Q.7 Are you prepared to state whether or not the Licensees meet the guidelines set out in Regulatory Guide 1.97, Rev. 2?

A.7 No. There is not sufficient information available at the present time for the Staff to make a decision with respect to the specific items listed in Regulatory Guide 1.97, Rev.2. Before a proper review can be made, additional details with regard to instrument criteria as well as Licensee's position will be necessary (see page 14 of Supplement 1 to NUREG-0737). Furthermore, it would be imprudent of the Sta'f t: make independent decisions with respect to Regulatory Guide 1.97, Rev.2 on one specific plant without the benefit of a careful and orderly review.

Q.8 Please state how the Staff plans to review Indian Point for compliance with the Regulatory Guide in question.

A.8 The Staff plans to perform an audit review of the Indian Point plants to ascertain conformance with R.G. 1.97, Rev.2, in conjunction with the Staff's review of emergency response capability. This audit review is not a prerequisite for implementation of R.G. 1.97, Rev. 2 (see page 14 of Supplement 1 to NUREG-0737). The schedule for implementing basic requirements for Emergency Response Capability is shown on page 1 of Supplement 1 to NUREG-0737. There it is stated that:

"The requirements for emergency response capabilities and facilities are being transmitted to Licensees by this supplement and are being promulgated to NRC Staff. The letter which forwards this supplement requests that Licensees submit a proposed schedule for completing actions to comply with the requirements.

Each Licensee's proposed schedule will then be reviewed by the assigned NRC Project Manager, who will discuss the subject with the Licensee and mutually agree on schedules and completion dates. The implementaion dates will then be formalized into an enforceable document."

Use of existing documentation is addressed on Page 3 of Supplement 1 to NUREG-0737:

"The following NUREG documents are intended to be used as sources of guidance and information, and the Regulatory Guides are to be considered as guidance or as an acceptable approach to meeting formal requirements. The items by virtue of their inclusion in these documents shall not be misconstrued as requirements to be levied on Licensees or as inflexible criteria to be used by NRC Staff reviewers."

R.G. 1.97, Rev.2 is included in the list of documents. Furthermore, pages 13 and 14 of Supplement 1 to NUREG-0737 discuss implementation of R.G. 1.97. Documentation and NRC Review is addressed on page 14 where it is stated that:

"Deviations from the guidance in Regulatory Guide 1.97, Rev. 2 should be explicitly shown, and supporting justification or alternatives should be presented."

Q.9 Please explain why completion of the Staff's review of the Licensee's compliance with Reg. Guide 1.97, Rev. 2 is not a pre-requisite for continued operation of the Indian Point facilities.

A.9 It should be understood that the Staff has not completed its review of conformance to Regulatory Guide 1.97, Rev.2 for any plant - neither for any licensed plant nor for plants under licensing review. Indian Point, as well as other plants for which the licensing review has been completed, was reviewed in accordance with GDC 13 and GDC 19 to insure that sufficient indications are available for the operator to cope with Design Basis Events.

Q.10 Does this conclude your testimony?

A.10 Yes.

JOSEPH P. JOYCE

PROFESSIONAL QUALIFICATIONS

INSTRUMENTATION & CONTROL SYSTEMS BRANCH

DIVISION OF SYSTEMS INTEGRATION

I have been with the U.S. Nuclear Regulatory Commission (NRC) since September 1974. Since November 1981 I have been a Principal Reactor Engineer in the Instrumentation and Control Systems Branch. My primary responsibilities are to review and coordinate reviews of all operating reactors Multiplant and Plant Specific actions in the area of instrumentation and control systems. I have performed reviews and developed review criteria for computer based protection systems and the safety parameter display system.

From April 28, 1980, I was assigned to the Human Factors Engineering Branch as a Senior Reactor Engineer technical reviewer. My primary responsibilities included reviewing control rooms from a human factors standpoint and developing human factros review guidelines for use by licensees to conduct their interim and detail control room design reviews.

Following the TMI-2 accident, from May to December 1979, I was assigned to the Bulletins and Orders Task Force as a technical reviewer in the area of instrumentation and control.

From September 1974 to May 1979, I served as a technical reviewer in the Instrumentation and Control Systems Branch (ICSB). In the ICSB, my primary responsibility was to perform technical reviews of the design, fabrication, and operation of electrical, instrumentation, and control systems for nuclear power plants. This review encompasses evaluation of applicants' safety analysis reports, generic reports, and other related information on the instrumentation and control designs.

From 1973 to 1974, I was a design engineer with NUS Corporation, where my duties included design responsibility in meteorological systems.

From 1969 to 1973, I was a system design engineer at Hydrospace Challenger Research, Inc. and was responsible for design, analysis, and preparation of electrical and wiring diagrams for the signal Converter and Switching Cabinet (SC) 2, which is the interface between the Simulation Computer AN/UYK-7 and the Central Computer Complex. In this position, using Fortran IV, I developed a working model of the hydrophone, cable, and preamplifier of the TRIDENT Sonar System.

I received a Bachelor of Science degree in electronic engineering in 1969 from Capital Institute of Technology. I am a member of the Institute of Electrical and Electronic Engineers (IEEE). I have authored and co-authored technical papers for presentations at conferences, hearings, review groups and publications.

MR. McGURREN: Your Honor, the Staff is ready to begin testimony on Board question 1.4

JUDGE GLEASON: All right. If you'd bear with me for just a minute.

The Board, in connection with question one, is going to utilize the services of a technical person or a person with technical background, and I wanted to get it on the record so that you know of it. His name is Paul J. Amico, A-m-i-c-o. He is President of Applied Risk Technology Corporation in Columbia, Maryland.

Mr. Amico has a background in probabilistic risk assessment work. He was an associate engineer for the Northeast Utility Service Company in Hartford, Connecticut, between 1977 and '79. His responsibilities at that time were projects of risk and reliability analysis.

He was senior staff engineer, Science Application, Inc., '79 to '83. He managed projects in risk and reliability analysis. And I believe he has just left SAI, recently left when he started this new organization which I mentioned originally.

He's a member of the American Nuclear Society and the Society for Risk Analysis. He is the author of many technical papers. He has a B.S. in nuclear engineering from the Rensselaer Polytechnic Institute, 1976, and he has received a number of awards.

The Board will utilize Mr. Amico in analyzing the testimony and reviewing with the Board where, if any, the record is deficient, with respect to the testimony on this one issue. He will be giving the Board a report and the Board will make that report on that record -- will furnish that report on the record, and will -- it will offer the parties an opportunity to submit by affidavits responses to that report if they desire.

We have been assured that Mr. Amico, although obviously the field of the experts in this field of probabilistic risk assessment is rather small, that he has worked, of course, with individuals who have been involved and are involved in one way or another with Indian Point work in the past. He is not currently and does not expect to be in the future involved with any of those individuals, and we think there's enough of a detachment from it that there's no conflict of interest.

In any event, I wanted to make you aware of the thing and I have done so today.

Mr. Brandenburg.

MR. BRANDENBURG: Mr. Chairman, I should state for the record that, while I do not know Mr. Amico, that representatives of Consolidated Edison and I believe the Power Authority met with SAI during the period that Mr. Amico was connected with them and discussed matters related to the Indian Point probabilistic risk assessment and our strategies and strategic planning for these hearings.

So I do not know if that is a problem, but I think it is something that I at least feel should be brought up at this time.

JUDGE GLEASON: I appreciate your doing that. In conversations Mr. Amico has had with two members of the Board -- I was not present -- he indicated and assured them that he was not personally involved in the IPPSS.

MR. BRANDENBURG: Well, our discussions were a little broader than just IPPSS. But in any event, we'll have to see how that turns out.

JUDGE GLEASON: Okay.

MR. LEVIN: Mr. Chairman, this is a common question for both Judge Amico or consultant Amico --

JUDGE GLEASON: Yes. He will not be a judge.

MR. LEVIN: -- and Judge Laurenson.

JUDGE GLEASON: Judge Laurenson, that is different.

MR. LEVIN: What about the service of

documents upon those gentlemen? What will we be expected to provider?

JUDGE GLEASON: You will not have to provide any service to Mr. Amico. You can just service the Board and the Board will furnish him the information, because he in effect is like a staff assistant to the Board in the context of what we're talking about.

As far as Mr. Laurenson, I'm glad you raised that. He should be served with papers dealing with the emergency contentions up until the time he makes his report to the Board.

Thank you.

MR. BLUM: Your Honor, we would reserve any objections based on the information Mr. Brandenburg has provided.

JUDGE GLEASON: All right, that's fine.

Go ahead, Mr. McGurren.

MR. McGURREN: The Staff is ready to proceed with Board question 1.4 and we call Dr. Hugh W. Woods and Raymond W. Klecker. They have not been sworn, Mr. Chairman.

(Witnesses sworn.)

Whereupon,

HUGH W. WOODS

and RAYMOND W. KLECKER,

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

DIRECT EXAMINATION

BY MR. McGURREN:

Q Gentlemen, will you please state for the record your full name and business address?

A (WITNESS WOODS) I am Hugh Wilroy Woods. I work for the Nuclear Regulatory Commission in Bethesda, Maryland.

A (WITNESS KLECKER) I'm Raymond W. Klecker. I'm a section leader in the Materials Engineering Branch, Nuclear Regulatory Commission, Washington, D.C.

Q Dr. Woods, would you also state your position with the NRC.

A (WITNESS WOODS) Yes. I hold a position called Task Manager, t-a-s-k, of Pressurized Thermal Shock.

Q Do you have before you a copy of testimony titled "Dr. Hugh H. Woods and Raymond W. Klecker on Board Question 1.4"?

A (WITNESS WOODS) Yes, I do. It's Hugh W. Woods. You said "Hugh H. Woods".

Q I'm sorry.

Mr. Klecker, do you have a copy of this

testimony before you?

A (WITNESS KLECKER) I do.

Q Was it prepared by you or did you participate in its preparation?

A (WITNESS KLECKER) We prepared it jointly.

Q Do you have any additions or corrections?

A (WITNESS KLECKER) Yes, I do. I have four fairly simple corrections I'd like to make at this time.

If you have it in front of you, if you'd turn to page 4. On page 4, the first question Q-6 and answer 6, there are three numbered paragraphs. Paragraph number 2, number 2, starts out, "The delta RT_{NDT} is obtained as described in the response to question 3." That is erroneous. It should be "question 4."

On page 5 I have two corrections, a similar correction in answer 8, the very last answer. 8 says, "in response to question 3." That should also read "question 4."

Has everyone found that?

JUDGE GLEASON: Can you hold a minute, please.

Okay.

WITNESS WOODS: Okay. On the same page, answer 9 reads, "Indian Point 2 and 3 are more than ten years behind." We would like to change that to read, "Indian Point 2 and 3 are" -- strike "more than ten" and insert "a number of." So it now reads, "Indian Point 2 and 3 are a number of years behind the plants."

BY MR. McGURREN: (Resuming)

Q While we are at that page, can I stop you and can you explain why you changed that testimony?

A (WITNESS WOODS) Yes. We have been very active in following the core loading changes, the flux reduction activities of the plants on the top of the list, and we found that they have -- they're all in some stage of implementing flux reductions, which will make the lead plants later in reaching the screening criteria.

In other words, that pushes them out closer to Indian Point. Therefore, the comparison in the statement that Indian Point is ten years behind the lead plants may not be true, because of the activities of the lead plants.

Q Do you have any other corrections or additions?

A (WITNESS WOODS) Yes, I have one more. Page 9, I have one very simple typo I would like to correct. On the fourth line, which is "r" apostrophe, please insert an "s" after the apostrophe. That's it. That is all of my corrections.

Q With these changes to your testimony, is it true and correct to the best of your knowledge, information and belief?

A (WITNESS WOODS) Yes, it is.

A (WITNESS KLECKER) Yes, it is.

Q Do you adopt this as your testimony in this proceeding?

A (WITNESS WOODS) Yes, I do.

MR. McGURREN: Copies of this testimony have been delivered to the Board and the parties and to the court reporter. I ask at this time that they be received into evidence as though read.

JUDGE GLEASON: Is there objection?

Hearing none, the testimony of the witnesses will be received into evidence and bound into the record as if read.

(The document referred to, the prepared testimony of Messrs. Wood and Klecker, received in evidence, follow:)

(V)

#3

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. (Indian Point, Unit No. 2)	)	Docket Nos. 50-247-SP 50-286-SP
	)	
POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit No. 3)	)	

DR. HUGH W. WOODS AND
RAYMOND W. KLECKER ON BOARD QUESTION 1.4

Q.1 What is the purpose of this testimony?

A.1 The purpose of this testimony is to respond to Board Question 1.4 which states:

> Board Question 1.4
> What risk to public health and safety is presented by the Indian Point plants through a chain of events including pressurized thermal shock to the reactor pressure vessels?

Q.2 How do you propose to address Board Question 1.4. concerning risk to public health and safety?

A.2 The Staff has not yet been able to complete a realistic assessment of offsite risks. The Staff, however, has developed a conservative analysis of frequency with which accidents entailing PTS lead to through wall cracking of the pressure vessel.

Q.3 Describe the pressurized thermal shock problem.

A.3 Pressurized thermal shock (PTS) is currently being investigated by the NRC Staff and the nuclear industry. PTS refers to an accidental rapid cooldown of the water in a reactor vessel while the system pressure is maintained at a high enough level to cause concern for those vessels that have experienced a significant degree of radiation damage. A rapid cooldown of the inner surface of a reactor vessel causes thermal stresses in the vessel wall. These stresses combined with pressure stresses may cause any preexisting small cracks to grow larger. The likelihood of crack growth under PTS conditions increases with radiation damage, a phenomenon that is understood and monitored. It means that reactor vessel materials lose some of their initial toughness or resistance to cracking due to neutron irradiation.

Q.4 How is the degree of radiation damage estimated?

A.4 Appendix H of 10 C.F.R. Part 50, "Reactor Vessel Material Surveillance Program Requirements" specifies that each licensee implement a surveillance program to monitor the changes in fracture toughness of materials in the reactor vessel beltline region resulting from exposure to neutron irradiation. Surveillance capsules containing neutron dosimeters and representative samples of the vessel materials are placed inside the reactor vessel between the core and the vessel wall. At this location they are exposed to a higher neutron fluence than is experienced by the vessel and hence, after any given period of reactor operation, they will have suffered greater neutron damage than the vessel itself. Periodically during the life of the facility, capsules are withdrawn, the material samples are tested to determine the change in properties and neutron dosimetry is performed to check the analytical predictions of neutron fluence. From the surveillance test results for all plants, "trend curves" are developed that predict the extent of radiation damage as a function of the neutron fluence and the chemical composition of the steel. Experimental studies of radiation damage are also studied for input to trend curve development. The measure of radiation damage is called "delta RT_{NDT}", the increase in the "reference temperature, nil-ductility transition." When values of delta RT_{NDT} for each plate, forging and weld in the reactor vessel beltline, are added to their respective initial (as fabricated) RT_{NDT} values, one can determine the controlling value of RT_{NDT} for a given reactor vessel. In some cases an axial weld may be controlling, in others, a circumferential weld, and in still other cases a plate or forging may be controlling, depending on their chemical composition and the fluence at their respective locations.

Q.5 What is RT_{NDT}?

A.5 RT_{NDT} is a single reference temperature chosen in a defined way to represent the temperature at which the material toughness (resistance to fracture), begins to increase rapidly with increases in temperature. At temperatures below the RT_{NDT}, the material is significantly less tough than at temperatures well above the RT_{NDT}.

Q.6 How is RT_{NDT} calculated for a given vessel at a given time in its life?

A.6 Three quantities are added together to obtain RT_{NDT} for a vessel. They are:

1. The initial RT_{NDT} of the controlling material is obtained from tests run in accordance with ASME Code rules at the time of vessel fabrication. If these results are not available, mean values from generic data for that material type are used.
2. The delta RT_{NDT} is obtained as described in the response to question 3, using the neutron fluence corresponding the the location in the vessel and the specified time in vessel life, and a trend curve that gives mean values of delta RT_{NDT} as a function of fluence and chemical composition.
3. Margin is added to give a conservative value of RT_{NDT}. For example, if mean values of initial RT_{NDT} and delta RT_{NDT} are being used, this third term is twice the square root of the sums of these squares of the standard deviations for the initial RT_{NDT} and the delta RT_{NDT}.

Q.7 Have values of RT_{NDT} been calculated for Indian Point 2 and 3?

A.7 Yes, the NRC Staff has made such calculations. They are based on information submitted in response to a request from the Staff, dated May 18, 1977, plus the information contained in the surveillance reports mentioned above. Because the Indian Point 2 and 3 plants are not among the plants of greatest concern with regard to pressurized thermal shock, the plant owners have yet to be asked to submit their current estimates of RT_{NDT}.

Q.8 Is there any additional evidence to be gained from the Indian Point 2 and 3 surveillance programs?

A.8 Yes, as of August 1982, two capsules have been withdrawn from each of the two reactors. The specimens in the capsules from Indian Point 2 have been analyzed by Southwest Research Institute. The specimens in one of the capsules from Indian Point 3 have been analyzed by Westinghouse and those in the other capsule are in the process of being analyzed. The results of these analyses confirm the Staff's calculations of RT_{NDT} for Indian Point 2 and 3 that were made based on trend curves as described in response to question 3 above.

Q.9 How do the Indian Point Vessels compare with those of other licensed nuclear plants with respect to the NRC Staff's estimate of their sensitivity to pressurized thermal shock?

A.9 Indian Point 2 and 3 are more than 10 years behind the plants of greatest concern with regard to the date at which they will exceed the NRC Staff screening criterion for sensitivity to pressurized thermal shock.

Q.10 What is the NRC Staff screening criterion for evaluating acceptability of reactor vessels to PTS related risk?

A.10 For axially-oriented welds, the criterion is an RT_{NDT} of 270°F. For circumferentially-oriented welds, which are more resistent to crack propagation due to greater stiffness of the vessel in that direction, the criterion is an RT_{NDT} of 300°F. For Indian Point 2 and 3, however, the 270°F RT_{NDT} criterion is the governing criterion. Accordingly, references to the screening criterion hereinafter will refer to the 270°F RT_{NDT} criterion.

Q.11 How was this screening criterion developed?

A.11 The criterion is based on deterministic and probabilistic fracture mechanics calculations for the most severe PTS events experienced during 350 reactor-years of domestic PWR operation, and on probabilistic risk analysis (PRA) studies of more severe events that have not occurred.

Eight events have been experienced in U.S. PWRs where final fluid temperature*/ reached 350°F or lower, the range where PTS could be a significant concern if the pressure is high and the cooldown is fast. Using the actual pressure and temperature histories of those eight events as input to a deterministic fracture mech[illegible] code which assumes presence of a wide range of flaw sizes, a se[illegible]ies of calculations were performed assuming a range of RT_{NDT} values.

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*/ Final fluid temperature is a value representing the lowest water temperature measured in the primary system during the PTS event.

Using this series of calculations, the critical RTNDT for each of the eight events was identified. Critical RT_{NDT} is the value of RT_{NDT} such that for a vessel with higher RT_{NDT} the most sensitive size flaw would be calculated to grow deeper during the event being considered, and for a vessel with lower RT_{NDT}, none of the flaw sizes would be calculated to grow deeper during the event. These calculations assume that the RT_{NDT} is exactly equal to the value stated, that the coldest measured temperature actually exists at the weld, and that a critical size flaw is present at the worst location.

Based on these results, a screening criterion selection was made at a value such that severe events would not be expected to jeopardize the vessel during the normal lifetime of a plant.

The study was expanded to include the expected frequency and calculated severity of PTS events which have not occurred. This expansion was made using event trees and probabilistic-risk-analysis techniques to obtain an approximate, quantified result.

A series of probabilistic fracture mechanics calculations was then performed which took into account such factors as actual material properties variations (the worst RT_{NDT} is probably not present at the coldest point) and actual crack size and distribution (a critical size flaw is probably not present at the coldest point).

In this way, a more realistic prediction of crack growth probability was made for the eight events that had occurred and for the more severe postulated events that had not occurred.

That prediction of crack growth probability confirmed that the selection of 270°F RT_{NDT} as the screening criterion is appropriate. A vessel that has a conservatively determined RT_{NDT} of 270°F (where the method of this determination is specifically prescribed) would have a frequency of crack extension without arrest between 10^{-5} and 10^{-6} per reactor-year. Although we cannot quantify the exact fraction, it is certain that not all through wall cracks will result in core melt since some crack sizes and crack shapes and crack locations will not preclude ability of the emergency systems to keep the core cooled. Therefore, the core melt frequency due to PTS events is lower than the stated frequency of PTS related crack extension without arrest.

Q.12 What level of confidence do you have that this criterion will accurately demonstrate that vessel failure is unlikely due to PTS events at Indian Point Units 2 and 3?

A.12 Of the eight significant PTS related events referred to in the previous question, five of the events occurred at plants supplied by the same vendor as the IP units (Westinghouse). Therefore, within the limited statistical precision represented by eight events, PTS events characteristic of the IP type plant are well represented. Additionally, the NRC analyses of events that have not occurred were largely taken from extensive analyses of Westinghouse plants performed by Westinghouse for the Westinghouse Owner' Group. Therefore, our screening criteria is closely tied to the IP units' general plant type and design, and we believe, therefore, that the screening criterion is acceptable for and applicable to the IP units. The uncertainties inherent in the development of the screening criterion are not of the type that can be handled statistically, so that a more precise answer regarding "level of confidence" in applicability of the screening criterion is not possible.

Q.13 What are the results of application of the screening criterion to the pressure vessels at Indian Point Units 2 and 3?

A.13 As of December 1981, Indian Point Units 2 and 3 were at RT_{NDT} values of 189°F and 212°F, respectively. This is 81°F and 58°F respectively below the applicable screening criterion of 270°F. When these plants are operating at 100 percent power the RT_{NDT} values increase approximately 7 degrees F per year.

Our estimate is that PTS risk decreases an order of magnitude for each approximately 40°F reduction in RT_{NDT}. On that basis, as of December 1981 the PTS risk at IP 2 and 3 is one to two orders of magnitude below the previously stated 10^{-5} to 10^{-6} frequency of crack extension without arrest for a plant at the screening criterion.

Based on our studies of PTS operating events and our calculations of PTS events that have occurred, both of which we believe are applicable to IP 2 and 3, we conclude that plants with RT_{NDT} below the screening criterion have a predicted frequency of vessel failure due to PTS events that is acceptable. Since Indian Point Units 2 and 3 are below this criterion their continued operation is acceptable.

We intend to require certain plants to take those actions that are reasonably practicable to reduce flux at the pressure vessel to slow the rate of increase of RT_{NDT}. For IP Units 2 and 3, a flux reduction by factors of approximately 1.4 and 1.9, respectively, would prevent reaching the screening criterion until beyond end of life of the plant, in which case the risk will remain acceptable through end-of-life at both units.

However, if such flux reductions are not possible, plant specific analyses will be required to be submitted three years before the criterion will be exceeded. The analyses will quantify PTS risk for the specific unit, and will identify the dominant contributing causes. If the risk is not acceptable at RT_{NDTs} above the screening criterion without corrective actions, appropriate actions would be required before the plant would be allowed to operate at RT_{NDT} values above the screening criterion.

Thus, present and continuing acceptability of PTS risk is assured.

PROFESSIONAL QUALIFICATIONS

OF

RAYMOND W. KLECKER

Jan. 10, 1982 to Date	Section Leader, Materials Engineering Branch Division of Engineering

Supervises the technical staff of a Section of the Materials Engineering Branch responsible: for conducting reviews and evaluation of the materials application, component integrity, and inservice inspection aspects of the reactor coolant pressure boundary and safety-related systems as described in applications for Construction Permits and Operating Licenses of nuclear power plants, or in proposed amendments to operating licenses, to assure public health and safety and protection of the environment; for the resolution of related technical issues and licensing problems; and for accomplishment of other functions and duties performed by the Section. Provides expert technical assistance and authoritative advice relating to the safety aspects of reactor plant materials engineering.

Sept. 7, 1980 to Jan. 10, 1982	Principal Materials Engineer Materials Engineering Branch Division of Engineering

Serves as a principal reviewer of material engineering aspects of nuclear reactors in the Materials Engineering Branch, Division of Engineering, by performing and coordinating reviews and evaluations of safety issues involving materials properties, and failure analyses. Serves as a group leader and coordinator of other reviewers to resolve complex technical issues and licensing problems. Provides specialized technical assistance and advice on materials engineering safety and licensing issues.

Specific assignments include development of analytical procedures for heat transfer, thermal stress and fracture mechanics evaluations of nuclear power facility components.

Feb. 8, 1978 to Sept. 7, 1980	Engineering Specialist, Principal Engineer Engineering Branch Division of Operating Reactors

As a person experienced in mechanical and materials and other engineering aspects of nuclear reactors, he serves as a highly qualified specialist in the Engineering Branch, Division of Operating Reactors. He is responsible for reviews, analyses, and evaluation of safety issues related to mechanical components of reactor facilities licensed for power operation. He also participates as a technical reviewer in evaluating applications for construction permits and operation licenses for non-power reactors and operational and design modifications of DOE- and DOD- owned operating facilities exempt from the licensing process. Specifically, the incumbent of the position is responsible for the mechanical and materials engineering aspects of the safety review of applications for license amendments for all licensed reactor facilities.

March 1, 1970 to Feb. 8, 1978 — Technical Coordinator, Assistant Director for Pressurized Water Reactors, Directorate of Licensing

Serves as a highly qualified technical specialist and administrative assistant to the Assistant Director for Pressurized Water Reactors, Directorate of Licensing. Coordinates technical reviews for the Pressurized Water Reactor branches. Provides liaison with the other Groups in the Directorate of Licensing and the Groups in the Directorates of Regulatory Operations and Regulatory Standards on technical matters relating to reactor safety. Guides and coordinates requests for technical assistance from other groups in the Directorates of Licensing, Regulatory Operations and Regulatory Standards and participates in codes and standards development by the Directorate of Regulatory Standards. Performs administrative service required in the discharge of the PWR Group's basic responsibilities.

Oct. 20, 1968 to March 1, 1970 — Chief, Advanced Concepts Branch, Division of Reactor Licensing

The Programs & Planning Branch is redesignated the Advanced Concepts Branch to more closely depict the functional responsibility which has evolved since the regulatory reorganization of February 1967.

Aug. 1, 1967 to Oct. 20, 1968 — Chief, Programs and Planning Branch, Division of Reactor Licensing

As Chief of the Programs and Planning Branch is responsible for (a) coordinating the development of procedures, methods and models for the technical review, analysis and evaluation of facility designs; (b) making long-range forecasts of future work-loads; (c) coordinating reviews and studies of reactor safety technology and reactor safety research and development; (d) developing the use of computer techniques for information, processing and storage, technical reviews, analyses and evaluations; (e) coordinating studies of licensing trends and techniques; (f) conducting safety reviews of aerospace projects; and technology; and (g) planning the technical seminar program.

Registered Professional Engineer - State of Maryland
Registration No. 4768 ME (Nuclear)

Education:

Bachelor of Science, Electrical Engineering, University of Southern California
Graduate of the Oak Ridge School of Reactor Technology
Graduate Courses at Illinois Institute of Technology, University of Wisconsin, Wayne University
Total 78 Credit Hours Post Graduate Courses
Completed Allis-Chalmers Business Administration course given by Marquette University
Completed Allis-Chalmers Seminar in General Management and Professional Managers Review Program

Industry Experience (prior to joining AEC/NRC):

Eighteen years professional experience, all with Allis-Chalmers and essentially all has been associated with the Company's atomic energy activities. Specific assignments have been:

1966 to Aug. 1, 1967 — Manager, Pathfinder Project, Atomic Energy Division, Bethesda Maryland

Responsible for completion of this project and turn-over of the plant to the customer (Northern States Power Company). Activities include direction of final tests of the Pathfinder plant at power, reporting of results of the post-construction research and development program, and close-out of the contract. (Note: During 1966 and 1967, Allis-Chalmers is in the process of phasing out of the atomic energy business. Consequently, the work and the number of personnel supervised during this period varied.)

1963 - 1966 — Manager, Analysis and Development Department, Atomic Energy Division, Maryland

As Manager of the Analysis and Development Department, Mr. Klecker was responsible for physics, thermal and hydraulics, dynamics, safeguards, and fuel cycle analyses as well as for the operation of the Division's mechanical, thermal and hydraulic and non-fuel materials development facilities. He coordinated his work with the Engineering and Fuel and Core Components Departments and provided services related to the above functions for the Projects and Application Engineering Departments and contributed to the overall Division planning.

1961 - 1963 — Manager of Engineering, Nuclear Power Department, Greendale, Wisconsin

As Manager of Engineering at the Nuclear Power Department-Greendale, Mr. Klecker was responsible for all analytical and design engineering at Greendale and management of thePathfinder project.

1958 - 1961 Project Engineer, Pathfinder Atomic Power Plant, Nuclear Power Department, Greendale, Wisconsin

During this period, Mr. Klecker was responsible for overall design and development of the Pathfinder Atomic Power Plant which includes a boiling water reactor with a nuclear superheater.

1956 - 1958 Supervisory Engineer in Charge of Reactor Design, Nuclear Power Department, Greendale, Wisconsin

1953 - 1956 Section Head, Instrumentation and Control Section, Atomic Power Development Associates, Inc., Detroit, Michigan (On Assignment by Allis-Chalmers)

1949 - 1953 Electrical and Nuclear Engineering (includes one year assigned to the Oak Ridge School of Reactor Technology)

Previous experience includes about four years as an officer in the U. S. Air Force, plus another four-five years as an industrial electrician with the HJL Booth Electric Company, Los Angeles.

Mr. Klecker has had extensive experience in electrical and nuclear engineering, including engineering analysis and design of reactor components. He is author of many documents on the theoretical analysis of electromagnetic pumps and other devices used for handling liquid metals which were developed by Allis-Chalmers as part of the U.S. Navy Submarine program. He was also responsible for analysis and engineering design of various nuclear reactors considered by Allis-Chalmers for development.

Miscellaneous:

Mr. Klecker is co-inventor of the Nuclear Superheater for Boiling Water Reactor (Patent No. 3,034,977) developed for the Pathfinder Atomic Power Plant.

For many years, Mr. Klecker represented the National Electric Manufacturers Association on the American Standards Association Committee N-6 and was a member of the Steering Committee associated with these activities. He also participated in various ad hoc assignments regarding standardization in the nuclear industry.

PROFESSIONAL QUALIFICATION
OF
DR. HUGH W. (ROY) WOODS

I am currently the NRC Task Manager for the Pressurized Thermal Shock Unresolved Safety Issue. In that position, which I have held since November 1981, I am responsible for coordinating and directing all NRC activities towards generic resolution of this issue. I am, therefore, familiar with all of the various aspects of the problem and its proposed resolution in the many technical discipline involved, including reactor system considerations.

Since 1973, I have been employed by the Nuclear Regulatory Commission or its predecessor, the Atomic Energy Commission, in various capacities as a Nuclear Engineer, most recently (before my present assignment) as the Office of Inspection and Enforcement principal reactor systems specialist for Westinghouse supplied nuclear plants.

Prior to 1973, I was employed by the E. I. DuPont Company at the Savannah River Laboratory, where I was responsible for various safety studies for their nuclear materials production reactors.

I hold Ph.D., M.S., and B. S. degrees in Nuclear Engineering with minors in Mechanical Engineering, Materials Engineering, and Electrical Engineering. These degrees were awarded respectively in 1969 and 1965 by the University of Florida and 1964 by North Carolina State University.

BY MR. McGURREN: (Resuming)

Q Dr. Woods, would you give us a summary of the testimony.

A (WITNESS WOODS) Yes, I can. The testimony describes and discusses the new pressurized thermal shock rule that we will establish. I will probably refer to pressurized thermal shock as PTS. Please bear with the acronyms.

The first thing the rule will do is establish a screening criteria based on the material property related to fracture resistance. This material property is called the reference temperature for the nil ductility transition, which I will probably refer to as RT_{NDT}.

The value of the screening criteria is selected so that pressurized thermal shock risk is acceptable for plants whose plant-specific RT_{NDT} is below the screening criteria. We have selected values of 270 degrees for plate and axial weld materials and 300 degrees for circumferential welded materials.

The plants, of course, will be required to evaluate their plant-specific RT_{NDT} for comparison to the rule, and when they are projected to be within three years of exceeding the screening criteria they will be required to do plant-specific safety analyses regarding pressurized thermal shock risk. Those analyses will also enable the identification of necessary corrective actions.

The bases for the rule that we will establish, very briefly. We looked at 350 reactor years of domestic operating experience and chose the most severe pressurized thermal shock events for attention. We supplemented that study of operating experience with probabilistic risk analysis studies, including deterministic and probabilistic fracture mechanics vessel analyses.

The results in general are that we believe plants whose RT_{NDT} is at the screening criteria will have a frequency of through-wall crack penetration between 10^{-5} and 10^{-6} per reactor year. We do believe that the screening criteris is applicable to the Indian Point units because five of the eight severe events that we looked at in detail were for Westinghouse plants, the PRA analyses that I referred to were for Westinghouse plants, and the Indian Point units are Westinghouse plants.

Specifically looking at the implications of the rule for Indian Point, we found that the reference temperature for the Indian Point units is considerably below the screening criteria. In fact, it is enough below the screening criteria that we believe the PTS risk of those units is somewhere in the range 10 to 100 times less than the value that I just stated for plants that are at the screening criteria.

We therefore believe no corrective actions are necessary at the present time, except for the fact that we will be encouraging many pressurized water reactors, including the Indian Point units, to take reasonably practicable actions to reduce the fast neutron flow into the pressure vessel.

That concludes my summary.

MR. McGURREN: Thank you.

Your Honor, the witnesses are available for Board questioning.

JUDGE GLEASON: Mr. Blum.

MR. McGURREN: Your Honor, I thought that only parties that were --

JUDGE GLEASON: In your absence, Mr. McGurren, we permitted Mr. Blum, in order to make the record more equitable and complete, to do some cross-examination of the witnesses. So we have reversed our original rule.

He does it very briefly, don't you, Mr. Blum?

MR. BLUM: Generally.

CROSS-EXAMINATION ON BEHALF

OF INTERVENOR UCS

BY MR. BLUM:

Q Dr. Woods, you mentioned in your change to, I believe it was, answer 9 that at one point Indian Point Units 2 and 3 had been more than ten years behind the plants of greatest concern. Could you give us any sense quantitatively how far behind they are now?

A (WITNESS WOODS) I'm not really prepared to do that. It is probably still in the range of ten years, because I understand from some conversations in the hallway that they are at some stage of committing to or implementing flux reductions at the Indian Point units. But not having the details of what they have done and not having finished the review of what the lead plants have done, I really can't.

I've got two moving targets that you're asking me to compare and I cannot do it quantitatively. But it is not significantly different from the ten years level.

Q So you're saying that they are implementing these flux reductions at the Indian Point units currently?

A (WITNESS WOODS) I have been told in the hall that certain actions are at some stage of completion -- I don't know what -- at one of the Indian Point units. I believe it was Unit 2. I don't have the details of that, though.

Q Do you know whether the Staff participated in the decision to have that implemented at Unit 2?

A (WITNESS WOODS) To my knowledge we did not. In a general sense, the industry is aware of our efforts and our encouragement to reduce flux. It's sort of like the traffic policeman. If you're not speeding, you know, it doesn't necessarily mean that the policeman actually stopped you and said don't speed; it means that you are aware that that encouragement is there.

So I don't know how to answer your question really specifically. We did not order them to do it. We have been encouraging them to do it. Many plants, most plants high up on the list, have done something and are planning to do more. They are in that group.

Q Did the two of you yourselves do the encouraging or would that have been other people on the Staff?

A (WITNESS WOODS) Well, I am the task manager, which my more proper title would be task coordinator. My management is really in a better position to do that type of encouraging, all the way up through the Commission.

They have made it quite clear that they want to see reasonably practicable efforts to reduce the flux. The entire Commission and the Staff has made that clear. So I would not take personal credit for it, although I participated in it.

Q So you did feel this was a problem worthy of some concern at the present time; is that correct?

A (WITNESS WOODS) No, that is not quite correct. It is more in the nature of we are trying to avoid a future problem. We do feel that the risk is acceptable for plants whose RT_{NDT} is below the screening criteria. We are trying to avoid a future situation where you have precluded the option of reducing risk by flux reduction.

It doesn't do you any good to close the barn door when the horse is out, and this is the type of action that has to be done early.

Q How would that type of future situation ever arise where you had precluded the option of reducing what you're trying to reduce?

A (WITNESS WOODS) Well, if you wish to reduce pressurized thermal shock risk one way to do it is to avoid high reference temperatures, and the way to do that is to reduce the flux. But you have to reduce the flux before it occurs.

I'm not sure I'm answering your question.

Q What happens if you don't reduce the flux in sufficient time? What options are you then left with?

A (WITNESS WOODS) Well, there are other options, certainly, which I guess I had better emphasize, the fact that the basic nature of the screening criteria in the pressurized thermal shock rule is to collect the information, to require the analyses that would identify the necessary corrective actions before you need to actually have them in place.

In other words, before you exceed the screening criteria these analyses are necessary. They identify the corrective actions in time for you to implement them before you see the screening criteria.

The type of actions that you're asking me about are operator improvements, equipment improvements, warming the refueling water storage tank. The possibility of annealing the vessel, of course, has been mentioned. Those are an off the top of the head list of corrective actions.

But the purpose of the rule and the analyses required by the rule is to do a much more thorough plant-specific job of identifying the problems and the corrective actions for the particular plant.

Q When you say "equipment improvements, you mean replacing pieces of equipment; is that correct?

A (WITNESS WOODS) That is certainly included.

It is not limited to that.

Q Mr. Woods -- is it "Mister" or "Doctor"?

A (WITNESS WOODS) It's "Doctor."

Q I'm sorry. Mr. Klecker, is it "Mister" or "Doctor" Klecker?

A (WITNESS KLECKER) No, it's "Mister."

Q Mr. Klecker, could you tell us how RT_{NDT} is determined beyond what is in your testimony?

A (WITNESS KLECKER) It is determined by a set of procedures that are spelled out in the ASME documents. It is an agreed upon temperature or way of measuring where the transition between the more brittle behavior of metals departs and where the toughness increases to some upper value.

This transition takes place over roughly about 100 degrees, so you have to define specifically where RT_{NDT} is and agree upon it, and this has been done by the ASME.

Q Could you tell us anything about the numbers -- I'm sorry, about the mathematical process by which that number is arrived at, Mr. Klecker?

A (WITNESS KLECKER) I'm not sure I understand your question. You mean how RT_{NDT} is arrived at?

Q Yes.

A (WITNESS KLECKER) Could I refer to the testimony we have prepared?

Q Certainly.

A (WITNESS KLECKER) On page 4, there are three quantities identified that add up to the total RT_{NDT} of a particular vessel. The first one is the initial RT_{NDT} --

JUDGE GLEASON: You're just going to read the testimony. Mr. Blum, so why don't you go ahead.

MR. BLUM: All right.

BY MR. BLUM: (Resuming)

Q Well, first of all, for the initial RT_{NDT} could you tell us about the calculations that are used to get that figure?

A (WITNESS KLECKER) That isn't done by a calculation. That is done by a series of tests, which are defined again by the ASME procedures.

Q Well, could you tell us anything about how those test results are interpreted or how they are translated into initial RT_{NDT} figures?

A (WITNESS KLECKER) What they do is take a number of small specimens and actually fracture them at different temperatures, and from that they can determine what the initial RT_{NDT} is.

Q Yes, I know the things that are in the testimony. But I would like the process of going from the fractures to the quantitative numbers that that translates into.

JUDGE SHON: Mr. Klecker, I think what Mr. Blum wants to know is, obviously, you have to run something on the order of impact tests or things like that at different temperatures. You obviously cannot do that on the weld itself as it sits in the reactor vessel having been fabricated. How do you know what the original value is? What have you done, and what assumptions have you made concerning the fact that the little samples you broke weren't really the pressure vessel itself? Do you see what I mean?

WITNESS KLECKER: Yes, I see what you mean, but in reality, to the extent possible, these are specimens made from the weld itself, actually extensions of the weld in the vessel itself.

JUDGE SHON: Well, that is the sort of thing I mean. They are made from extensions of the weld, and samples are prepared, and nothing is done to them that would changes these values between when they are taken from the as fabricated material and when they are tested and so on. Is this the sort of thing that you mean?

WITNESS KLECKER: Yes. In some cases, however, when it is not practicable to get a sample directly from the weld itself, a special weld block is made with the same identical procedures, and then from that the samples or specimens are obtained.

BY MR. BLUM: (Resuming)

Q Is that what you mean, if these results are not available, the mean data for that of generic material are used?

A (WITNESS KLECKER) Yes, that is correct.

Q Could you tell us in a situation where you do have the samples let's say you have taken five samples. What do you do next to go from those samples to what is going to be your initial RT_{NDT} value?

A (WITNESS KLECKER) From the samples that are broken, you know, in this test that I referred to, some of them at colder temperatures will fracture, and then as you proceed to higher temperatures, they no longer fracture, so by the rules, then, you can determine a value of RT_{NDT} from that.

Alternatively, we do what they call the Sharpy tests, which are a similar type of test, and from that you can determine a curve which results in a toughness variation versus the temperature of the material.

JUDGE SHON: Could I just ask one thing? Do you happen to know whether at Indian Point the original RT_{NDT} was actually measured, or was it obtained by generic data for the material type used? Or is it in some cases one thing and in some another?

WITNESS KLECKER: I am not certain of the answer to that. Our records, however, do give us values, but I am not sure how they were determined.

BY MR. BLUM: (Resuming)

Q Dr. Woods, do you know how they were determined?

A (WITNESS WOODS) No, I don't.

Q Does either of you know who did the determining?

A (WITNESS WOODS) I certainly know who on the test boards that I work with generated that information, and I know that he has a file of previous inquiries and so forth, and he has the best available information, but he is not here today, so I can't turn around and ask him for what particular item he pulled out of his file.

A (WITNESS KLECKER) In general, the tests are done by the manufacturer of the vessel. Either he does it himself or he has it done for him. In this case, these were Combustion Engineering vessels in both cases, so conceivably Combustion Engineering, so I am not sure of the answer.

Q So you are saying it was not done by the staff?

A (WITNESS KLECKER) Oh, no, the staff does not do this kind of test.

Q With regard to the person or persons who did do it, did either of you consult with him or consult his file before coming here to testify?

A (WITNESS KLECKER) We have not done so on the Indian Point facilities simply because they are far enough downstream. We have had conversations with some of the other utilities.

A (WITNESS WOODS) I think there is a confusion here. When you refer to the person who did it, do you mean the person who generated these numbers for us or the person who did the original test? Because I got confused in your previous question. Which are you referring to?

Q I was following up on Judge Shon's question about the original test.

A (WITNESS WOODS) Okay. Certainly neither of us have talked to the person who did the original test.

Q Mr. Klecker, right before our last series of questions, you had said you do these tests and then by the rules you come out with the RT_{NDT} values. Could you tell us what the rules are that enable you to go from those tests to the RT_{NDT} values?

A (WITNESS KLECKER) I don't have them available wtih me here today. They are documented ASME procedures. It is an arbitrary procedure that has been agreed to to go from the test information to a value of

RT_{NDT}, initial RT_{NDT} in this case.

Q So you are saying it is a shared assumption about how you do it? Is that correct?

A (WITNESS KLECKER) It really isn't an assumption. It is an agreed upon procedure.

JUDGE SHON: I think what needs to be clarified here a little bit is that Mr. Klecker's view of this is, I think, closer to the fact that there is an agreed upon procedure which truly defines a single temperature. The transition takes place over a range of temperatures, and you don't know which one to call it. Is that correct? And there is a defined procedure which defines a single temperature after looking at the behavioral overall range of temperatures, and that single number is what you use. Is that correct?

WITNESS KLECKER: That is correct.

BY MR. BLUM: (Resuming)

Q Well, could you tell us anything more about how you arrive at that single number from the test results?

A (WITNESS WOODS) This is out of my field somewhat, but I have been associated with it. Basically, it specified that you run a certain number of tests at different temperatures, and you measure the foot pounds of energy that it takes to break the samples, and you measure, and of course you know the temperature, and the exact procedure escapes me, but it has to do with the temperature range where you require 50 foot pounds or 35 foot pounds or whatever to break the sample.

It is that type of procedure. I didn't memorize it. I am sorry. But it is written down, and it is that type of procedure that just has you look, when you get below a certain energy required to break the sample, you are below the reference temperature. There is some conservatism built into it, but I am unable to quote for you right here exactly how much it is.

Q I am sorry. There were a couple of words you said that I didn't hear completely clearly. You said 50 foot bins and 35 foot bins?

A (WITNESS KLECKER) Pounds. Oh, okay.

JUDGE SHON: Mr. Blum, a foot pound is a measure of energy. What these people measure is the amount of energy it takes to fracture or break a part, a single well defined standard sample, and they look at it, and it varies, and there is a number at which it has a certain value.

WITNESS WOODS: It is a cute little test. You stick the sample up, and you have a heavy hammer come flying down and hit it, and that hammer has a certain amount of energy, and you can measure how much energy is in it after you break it by how far it goes up the other side. And the difference is the energy that it took to break the sample. So it is a well defined standard procedure.

BY MR. BLUM: (Resuming)

Q Thank you. I just didn't hear you before.

Mr. Klecker, does not the percentage of copper in welds on the pressure vessel affect RT_{NDT}?

A (WITNESS KLECKER) It affects the delta RT_{NTD} that we specify. In the second of my two parameters, you go in there. It doesn't affect the initial significantly.

Q Do you know the percentage of copper at Indian Point?

A (WITNESS KLECKER) Yes. At Indian Point 3, the numbers we have are .24 percent copper. At Indian Point 2, the numbers are .34 percent.

MR. MC GURREN: Your Honor, just so the record is clear, could you ask the witness to indicate with respect to what he is identifying copper level?

JUDGE GLEASON: What is that reference out of?

WITNESS KLECKER: You mean, what am I getting the numbers from?

MR. MC GURREN: No, not what you are looking at in terms of your document there, but when you identify copper level, are you referring to the weld?

WITNESS KLECKER: These are the copper content of the critical welds in these vessels.

MR. MC GURREN: Thank you.

BY MR. BLUM: (Resuming)

Q Mr. Klecker, how are cracks in the pressure vessel detected?

A (WITNESS KLECKER) We don't test cracks in the pressure vessel. I don't know exactly what you are referring to.

A (WITNESS WOODS) Let me take an attempt at that. We do inspections of the vessel, but basically in the analyses that I referred to, we arbitrarily assume the presence of a crack, even though we have not found one and do not believe it would exist.

Q Yes. I understand that. But what inspection procedure do you use to try to detect cracks?

A (WITNESS KLECKER) It is an ultrasonic testing procedure, sound waves.

Q Could you tell us what crack sizes and locations are detectable using ultrasonic detection?

A (WITNESS KLECKER) The more sophisticated techniques that are being used today can letect flaws less than one inch in depth. Some of the inspection agencies claim they can find flaws as shallow as about a half an inch.

Q What would be a critical range of crack depths?

A (WITNESS KLECKER) For the pressurized thermal shock scenarios that we have investigated, the critical cracks, the cracks that are likely to grow, that is, under the thermal shock, is of the order of a half an inch up to roughly an inch and a quarter in depth.

Q How frequently is this type of inspection, looking for cracks, performed?

A (WITNESS KLECKER) Every ten years. Or approximately.

JUDGE PARIS: Did you say every ten years if possible?

WITNESS KLECKER: Approximately.

BY MR. BLUM: (Resuming)

Q Could you tell us what types of sequences can lead to pressurized thermal shock?

A (WITNESS KLECKER) The type of transient, you mean?

Q The type of initiating event to begin with and what follows from that.

A (WITNESS KLECKER) There are a number of events that conceivably can lead to a rapid cooldown of the vessel. They can originate in either the primary system or in the secondary system. In the primary system, a small break in one of the smaller lines or a stuck open valve can lead to a cooldown and depressurization and subsequent injection of emergency core cooling water which further cools the vessel down and potentially repressurizes it.

If the break is small enough so that the emergency core cooling system can overcome the leakage out of the crack, that is, that is one of the concerns. A much larger break, you get again the cooldown, but you cannot repressurize it. That is commonly referred to as the large break LOCA.

From the secondary side, a steam line break of any size can also lead to a rapid cooldown in the primary system, because the energy removed from the primary system causes it to cool down also. In addition to, say, breaks in the steam line or the feedwater lines, which again would be about the same, you can overfeed the secondary system by cold feedwater more than, say, for normal operation, in which case again you can remove more heat than you want to, and as a consequence the vessel or the water in the primary system will also cool down.

Those are the major events that are of concern.

Q In addition to these, what about spurious initiation of the emergency core cooling system?

A (WITNESS KLECKER) In general, that isn't a problem, because usually it is shut off before the primary system cools down more than, say, 50 degrees or so, which really isn't a shock to the vessel at all.

Q When you say usually it is shut off --

A (WITNESS KLECKER) The operator recognizes it as a spurious signal and terminates the ECCS flow.

Q But if the operator were not to do that, it would be a problem. Is that correct?

A (WITNESS KLECKER) Not necessarily, because the vessel at this time would have been full of water, and he can only pump in so much, because the pressurizer level would increase, and there are other systems in addition to the operator that would tend to terminate this flow.

Q For the various events you have listed, have you calculated the probabilities of those? Do you know the probabilities of those at Indian Point?

A (WITNESS KLECKER) We have not or I have not calculated the probabilities at either one of these facilities.

A (WITNESS WOODS) I am not sure I understand the question. Which events are you referring to?

Q Mr. Klecker listed a series of initiating events that would be of concern for pressurized thermal shock.

A (WITNESS WOODS) May I answer? Are you specifically addressing these to Mr. Klecker, or --

Q Well, go ahead. You can answer if you would like.

A (WITNESS WOODS) I really can't give you quantitative numbers for Indian Point. The effort that was made in doing the studies that will result in this rule was a generic effort, and by its very nature what you try to do is bound all of the plants of concern, and I don't think I can quote the numbers even there, but within the staff, we do have estimates of the probability or expected frequency of that type of event for all PWR's, and it would include Indian Point.

I can't quote the numbers for you. I might could find it somewhere here.

Q Are you familiar with the pressurized thermal shock precursor in the Crystal River plant?

A (WITNESS WOODS) Yes.

Q It is true, is it not, that there are some types of precursor events that are specific to a particular plant design rather than generically applicable. Is that not true?

A (WITNESS WOODS) That's true.

Q So a generic PRA would not necessarily pick up that sort of thing, would it?

A (WITNESS WOODS) It wouldn't. You wouldn't be guaranteed that you can't think of something that is outside the generic report. But in that particular case, of course, we were aware of the Crystal River event. It is one of the events that we considered in the generic development of this criteria.

Q Would the generic PRA be likely to have come up with that prior to the actual occurrence of the precursor?

A (WITNESS WOODS) I guess it is a yes and no answer. The exact details would not have been there, but the general type of event, the Crystal River event -- I believe it was a small break LOCA basically -- was certainly included and would have been included had Crystal River not occurred. That is not the best example, because Crystal River is an entirely different type of plant. We are talking about Indian Point here, and as I pointed out in the testimony, the operating experience and the PRA analyses were performed for

Westinghouse plants.

Q Did you review the generic PRA against the Indian Point plant's design to determine whether there were any features at Indian Point that would make it more or less likely than the generic?

A (WITNESS WOODS) Both licensees did that and submitted their comparison, their differences to us, and we reviewed those comparisons and differences.

Q But the staff itself did not conduct such a review?

A (WITNESS WOODS) Well, what do you mean --

Q Well, where you yourselves do the study.

A (WITNESS WOODS) No, we have not done a specific PRA analysis of the Indian Point units. The staff has not.

JUDGE GLEASON: Are you finished, Mr. Blum?

MR. BLUM: No, I am not. I am not finished. There is not a huge amount more.

WITNESS WOODS: I would point out to you that the rule is set up to require the licensee to perform such a plant specific study and for us to review it before the plant exceeds the screening criteria, but the answer to your question, have we done it, in past tense, the answer is no.

JUDGE PARIS: Before the plant does what? I didn't get that word.

WITNESS WOODS: Before the plant exceeds the screening criteria. Before it gets into the range where we have not now stated we think the risk is acceptable.

BY MR. BLUM: (Resuming)

Q You have mentioned that -- In your testimony, you have stated that a rather large fraction of the PTS precursor events have occurred at Westinghouse plants. Is that correct?

A (WITNESS WOODS) Yes, that's correct. Five of the eight, I believe. Hold on a second.

Whatever it said, and I believe I said five of eight.

Q Have there been any significant precursor events at Indian Point specifically?

A (WITNESS WOODS) I'm sure we're going to have an interesting discussion about this.

Of the eight events, none of them were at Indian Point. Of the eight events that we selected for detailed consideration, none of those eight were Indian Point. Based on our criteria for selecting those eight events, none have occurred at Indian Point.

Q Are you familiar with a study of pressurized thermal shock precursors done by Dong L. Thung?

A (WITNESS WOODS) Yes, I am.

Q So you are aware of the scale of severity of events that was used ranging from one to four?

A (WITNESS WOODS) Zero to four, I believe.

Q Four being the most severe?

A (WITNESS WOODS) That is correct.

Q And in that study it was found that an event level four had occurred at Indian Point, was it not?

A (WITNESS WOODS) Two events, I believe. Maybe one of them was level three. Hold on a second.

Two events, level four -- whoops. Yes, two events, level four, in the study at Indian Point.

Q Could you tell us how your screening criteria differed from that in the Dong L. Thung study?

A (WITNESS WOODS) I can at least give you a partial answer. Our screening criteria was quite simple. We looked for moderately rapid cooldowns to a temperature lower than 350 degrees. That was it for us. The details of the screening criteria are given in the summary, which I unfortunately did not memorize, but it involves the same sort of thing, the combination of pressure, cooldown rate and temperature.

But apparently, they would put less severe events in the top category than we did, because our screening criteria did not include these two events and theirs did.

Q Mr. Klecker, in the testimony it refers to a situation where neutron flux reductions might no longer be possible. Why would that be so?

A (WITNESS KLECKER) Well, of course you can always reduce flux. But if you allow the integrated flux or the fluence at the vessel wall to accumulate to the point where you approach the screening criteria, there is no way of reducing the fluence in the vessel. You can of course reduce the flux at any time.

Q And what is the significance of being able to reduce the fluence?

A (WITNESS KLECKER) Well, the fluence results in the damage done to the vessel, the radiation damage.

And the only way you could reduce that is by the annealing process that Dr. Woods mentioned earlier.

A (WITNESS WOODS) Fluence accumulation is a one-way street. Once you get to a certain level you cannot go back except by the annealing process.

It is an incorrect statement you made, or we made possibly, if we said you cannot reduce flux. You certainly can always reduce flux. You can lock the barn door after the horse is out, but it doesn't do you any good.

Q Toward the end of your testimony you stated something to the effect that you could not quantify the uncertainty as to the appropriateness of your 270 degree Fahrenheit figure; is that correct?

A (WITNESS WOODS) I believe that was part of the testimony I prepared. Where are you exactly?

JUDGE GLEASON: What page, Mr. Blum?

(Pause.)

JUDGE GLEASON: There's something in the middle of page 8 about quantifying.

MR. BLUM: I believe that is correct.

BY MR. BLUM: (Resuming)

Q Could you tell us anything more -- well, let me ask you this. You say you cannot quantify the exact fraction. Can you give us a rough estimate of the range of uncertainty, even though it is not exact?

A (WITNESS WOODS) No, I can't give you a quantitative estimate of the uncertainty. There is a great deal of professional experience and judgment that went into the determination of the screening criteria, and many of the elements that went into it simply don't lend themselves to the type of quantification that you are asking for.

Q Can you do it qualitatively for us?

A (WITNESS WOODS) Yes. I personally, and the Staff consensus is, that we are sufficiently confident in this result that we feel the risks with the plants with the RT_{NDT} below the screening criteria is acceptable. To quantify it for you is what I cannot do.

Q Well, so there is some possibility, then, that the appropriate number would be 250 degrees or 290 degrees, rather than 270; is that correct?

A (WITNESS WOODS) If you're asking can I prove that it's 270, not 290, the answer is no, I cannot. My belief is that 270 is sufficiently conservative so that the risk is acceptable for plants below 270.

Q In addition to not proving, you cannot give us any kind of probabilistic estimate that it is not 290 or 250?

A (WITNESS WOODS) That is correct, I cannot.

Q You could, for example, that it's not 600, right?

A (WITNESS WOODS) I doubt if I could even do that.

Q If it were 250 rather than 270, would this raise or lower the probability of pressurized thermal shock occurring at Indian Point?

A (WITNESS WOODS) It wouldn't change it, but I don't understand your question. Please rephrase it. It doesn't seem to make sense.

The probability of a pressurized thermal shock event occurring or not occurring is totally independent of wherever we arbitrarily choose to set the screening criteria. That is why your question doesn't make sense.

Q Is it not likely that some of the same mental processes and conclusions that go into your setting the screening level would also be used in doing PRA?

A (WITNESS WOODS) Yes.

Q So what I am saying is, if your assumptions are wrong here or your conclusions are wrong about the appropriate level, that would mean that there would probably be some sort of analogous error going on in the PRA's as well, would it not?

A (WITNESS WOODS) It is certainly possible.

Q And that error, if it existed, would affect the validity of the result of the PRA by some amount, would it not?

MR. McGURREN: Mr. Chairman, I think we're getting beyond the scope of these witnesses' testimony. They did not do the PRA. The scope of their testimony is limited to pressurized thermal shock, the Board question on pressurized thermal shock.

MR. SOHINKI: Further, Mr. Chairman --

JUDGE GLEASON: Do you want an answer to that question?

MR. BLUM: Yes, if they're willing to.

JUDGE GLEASON: Please answer the question.

WITNESS WOODS: Please repeat the question.

BY MR. BLUM: (Resuming)

Q If the analogous error which resulted in your screening criteria being off by say 20 degrees were made in a PRA, that would affect the validity of the results of the PRA by some amount, would it not?

MR. McGURREN: Your Honor, I object to that question. It's assuming there is an error.

JUDGE GLEASON: It's a hypothetical question. He can say he doesn't know.

MR. SOHINKI: Mr. Chairman, if I can make a point, hypothetical points have to be based on evidence that is in the record or provided in the record. It is an improper hypothetical to base a question on evidence that either is not in the record or will not be produced in the record.

MR. BLUM: The witness stated he did not know and could not say definitely that 270 degrees was correct as opposed to 250 or 290.

MR. McGURREN: That is not what the witness said.

JUDGE GLEASON: Go ahead and ask the question, Mr. Blum.

BY MR. BLUM: (Resuming)

Q Do you remember the question?

A (WITNESS WOODS) I would like for you to repeat it again, because I had some uncertainties about -- well, for example, when you referred to a PRA, I would like to know what PRA you are referring to.

JUDGE GLEASON: He didn't ask that question. He asked about PRA in general.

MR. McGURREN: Your Honor, I think that has to be clarified, because I think the witness might be thinking of another PRA.

JUDGE GLEASON: Ask the question again.

BY MR. BLUM: (Resuming)

Q Okay, let's back up a second. What PRA are you referring to in your testimony?

A (WITNESS WOODS) Where?

Q I believe you only refer to one PRA in your testimony. There's a generic PRA. That is the one in your testimony, is it not?

A (WITNESS WOODS) Okay, you are referring then -- okay, I'm now aware of what PRA you are talking about.

Q Do you wish to identify that further for us?

A (WITNESS WOODS) There was a rather extensive study done by Westinghouse for Westinghouse plants generically, that we used extensively in the development of this proposed pressurized thermal shock rule, and that I believe is what you are referring to.

(Pause.)

A (WITNESS WOODS) Oh, yes. Mr. Klecker points out, you are probably confused, or all of us are. When I refer to PRA here, I am talking about PRA's that were directed exclusively at the pressurized thermal shock risk, not a general PRA for all types of risk.

JUDGE GLEASON: I think that question is beyond the pale of his testimony, Mr. Blum. He's not here as an expert on PRA's.

BY MR. BLUM: (Resuming)

Q Well, do you vouch for the accuracy of the figures between 10^{-5} and 10^{-6} per reactor year?

A (WITNESS WOODS) Yes.

Q And are those derived by a PRA?

A (WITNESS WOODS) PRA was part of the studies and analyses that went into the development, as I have previously mentioned. They are not entirely based on PRA's. They are also based on the operating experience, events and others.

Q Well, who calculated these numbers 10^{-5} times, 10^{-6}?

A (WITNESS WOODS) The Staff did.

Q And that was based partly on the results of the Westinghouse PRA; is that correct?

A (WITNESS WOODS) That is correct.

Q And partly on the fact that there has not yet been an instance of pressurized thermal shock rupture at a plant; is that correct?

A (WITNESS WOODS) Certainly, yes.

Q So that experience, did that tend to lower the results that have been in the Westinghouse PRA?

A (WITNESS WOODS) I cannot answer you directly. The Staff collected knowledge from wherever we thought knowledge was to be had -- various studies in-house, external, PRA from Westinghouse, operating experience -- and we made our own judgment as to what the level of the screening criteria ought to be. It is not based on anything other than our own assimilation of the appropriate information that we could get.

Q Now, if the Westinghouse PRA were in error in some way, this would probably produce some analogous error in the figures you cite, would it not?

A (WITNESS WOODS) In fact, the Westinghouse PRA was in error in our opinion in some places, and we changed certain things before we used the results of the Westinghouse PRA. So certainly, yes, if there were errors that we allowed to stay, it would in some small degree affect the answer, yes.

Q Now, if in addition to the errors you did detect there were others which you did not detect, that would also likely affect the validity of your numbers here, would it not?

A (WITNESS WOODS) It could change them slightly. But I would like to point out again that the purpose of the rule and screenin eria that we are talking about is really a trig for plant-specific PRA and other efforts at the plant. So all you would do is change the exact timing of when these more specific, more accurate analyses would be done.

Q I understand that. But earlier we had discussed how some of the same assumptions that would go into your setting the level at 270 degrees would also go into a PRA. Do you recall that sequence about ten minutes ago?

A (WITNESS WOODS) Certainly if PRA methods are faulty, then you could make the point that if the same fault exists in the analyses that were done for the screening criteria and they come up again in the plant-specific analysis, it could affect the validity of the results.

Is that the point you're trying to make?

Q Well, that is the starting point. What I am trying to get at is some sense of the uncertainties that result from that. For example, hypothetically, if your estimate of 270 degrees were off by about 20 degrees and that same series of errors were propagated through the PRA, do you know roughly how much that would affect the probabilities derived in the PRA?

MR. SOHINKI: Objection, Mr. Chairman.

MR. McGURREN: This is beyond the scope of their testimony.

MR. BLUM: He cited numbers which are based to a considerable extent on the numbers in the PRA, and what I am trying to do is get at the extent of the uncertainty surrounding his numbers. If he doesn't know, he could just answer he doesn't know and I'll stop.

JUDGE SHON: Mr. Blum, are you trying to get him to say whether the numbers, frequency of crack extension between arrests, between 10^{-5} and 10^{-6} per reactor year, whether those numbers would be different were the screening criteria that he has set to be something substantially different from 270 degrees? Is that what you want to know?

MR. BLUM: Yes. But in addition to that, we would need to know that the same difference was in some sense propagated through the methods by which they calculated the 10^{-5} to 10^{-6}.

JUDGE GLEASON: Ask your question again, would you, please? Go ahead.

MR. BLUM: Maybe I'll just adopt Judge Shon's question by reference.

JUDGE GLEASON: That's all right.

JUDGE SHON: Let me ask the question. If you were substantially in error in assuming that 270 degrees Fahrenheit was a reasonably conservative screening criterion and all the calculations that resulted in the figures on page 8 of your testimony were done again and the real number was 500 degrees Fahrenheit, would this probability of crack extension without arrest change substantially from the 10^{-5} to 10^{-6}?

WITNESS WOODS: It would change. I think all of these questions are aimed at the sensitivity of the risk numbers to errors in the reference temperature screening criteria.

JUDGE SHON: Exactly.

WITNESS WOODS: Fine. Then please refer to the last paragraph on page 9 of my testimony, where we answer that question.

JUDGE SHON: I hadn't noticed that, although I have a note written next to it.

BY MR. BLUM: (Resuming)

Q Thank you.

And the other part of the question would be, then -- well, all right. I believe you stated you cannot quantify the likelihood of being off by 40 degrees?

A (WITNESS WOODS) That is correct, I cannot.

Q Thank you.

MR. BLUM: We have no further questions.

JUDGE GLEASON: Is there any cross on the part of Licensees?

MR. SOHINKI: Yes, sir, but none of the other Intervenors have any questions?

JUDGE GLEASON: They are not authorized to ask questions.

MR. SOHINKI: I have some questions, Mr. Chairman.

JUDGE GLEASON: Please proceed.

CROSS-EXAMINATION ON BEHALF OF
LICENSEE CONSOLIDATED EDISON

BY MR. SOHINKI:

Q Gentlemen, I'd like to start first with the last area that was discussed by Mr. Blum and try to put the risk numbers in your testimony into perspective as they relate to public health consequences offsite. The first question is -- well, let's start with this. You stated that you assumed the presence of a crack in the vessel wall, even though you don't believe one exists; is that correct?

A (WITNESS KLECKER) That is correct.

A (WITNESS WOODS) It is correct for certain parts of the analysis. In other parts we did take conservative account of our perceived probability of the existence of a crack. So it is kind of a yes and no answer depending on what part of the analysis you're referring to.

Q But that assumption is a conservatism in the analysis?

A (WITNESS WOODS) If you assume the presence of a crack where one does not exist, it is a conservatism, yes.

Q All right. Now, on the bottom of page 9 where you refer to the 10^{-5} to 10^{-6}, you also say that PTS risk at Indian Point Units 2 and 3 is one to two orders of magnitude below that. Is that correct, to say that we're talking about a PTS risk frequency of crack extension without arrest in the range of 10^{-6} to 10^{-8}? Is that right?

A (WITNESS WOODS) That is correct.

Q And am I also correct that in order to get any public health consequences offsite two additional things have to happen: Number one, you have to reach a state of core melt; and number two, you have to have a loss of containment heat removal capability? Is that correct?

MR. BLUM: I would object to this as being beyond the scope of the testimony.

JUDGE GLEASON: I'm talking up here with one of my fellow Judges. Ask the question again.

BY MR. SOHINKI: (Resuming)

Q The question was that the witnesses have stated their question indicates that PTS risk for the units in the range of 10^{-6} to 10^{-8}, and what I am trying to do is inquire into the relationship of that number as it relates to public health consequences offsite, to put it in some kind of perspective, because that is what we're really worried about here. And the question to the witnesses was, in order to get public health consequences offsite --

JUDGE GLEASON: That is beyond the scope of his testimony. The objection is granted.

BY MR. SOHINKI: (Resuming)

Q All right, let's ask this, gentlemen. You said that you are encouraging Licensees to take reasonably practicable actions to reduce neutron fluence levels or flux reductions in operating reactors, is that right?

A (WITNESS WOODS) That's right.

Q And you are familiar with the NRC Staff evaluation of pressurized thermal shock dated November 1982?

A (WITNESS WOODS) Yes, I am.

Q And did you gentlemen participate in the preparation of that document?

A (WITNESS WOODS) Yes, we did.

Q And am I correct that that document discusses a fuel management policy designated as a low leakage loading pattern?

A (WITNESS WOODS) Yes.

Q And could you explain briefly what a low leakage loading pattern is?

A (WITNESS WOODS) Well, it can encompass any number of things, but the basic objective is to put fuel elements on the outside of the core nearest the vessel that generate less neutrons, the more highly burned or dummy elements, or removal of elements. there are an infinite number of schemes, but they all involve some of those aspects.

Q And is that one method of achieving a flux reduction or neutron fluence reduction in operating reactors?

A (WITNESS WOODS) Yes.

Q In referring you. attention to Page 10 of your testimony, where you indicate that flux reduction, in the middle paragraph, that flux reduction factors of 1.4 and 1.9 for Indian Point Units 2 and 3 respectively would prevent reaching the screening criterion until beyond end of life, it is the staff's position, is it not, that flux reductions of that magnitude are achievable by implementing a low leakage fuel management program?

A (WITNESS WOODS) It is highly plant specific, but we believe such flux reductions are achievable.

Q All right. Now, did you gentlemen participate in the preparation of staff interrogatories to the licensees with regard to actions being taken to reduce pressurized thermal shock risk?

A (WITNESS WOODS) You are going to have to better define for me exactly what staff interrogatory. I have certainly written letters or participated in the writing of letters asking for information, but I don't believe one of the letters went to either of the Indian Point units.

Q These are specifically interrogatories that were sent by the staff on June 3rd, 1982, to the licensees with regard to Questions 1 and 2 in these proceedings. Do either of you gentlemen recall participating in the preparation of those interrogatories?

A (WITNESS WOODS) To my knowledge, I didn't, but I am still not quite clear on what you are referring to.

JUDGE PARIS: You mean interrogatories in this case?

MR. SOHINKI: That is right.

JUDGE PARIS: He means interrogatories submitted in this case.

WITNESS WOODS: We participated in Board Question 1.4, and there was some previous intervenor contention or whatever that was withdrawn that we had participated in. Other questions we have not participated in.

JUDGE GLEASON: Mr. Sohinki, pursue it. Ask him if -- Well, go ahead.

BY MR. SOHINKI: (Resuming)

Q Let me read the response that the licensees submitted in part to those interrogatories, and I want to ask you if you are familiar with the response. This is in response to Interrogatory Number 7 in the staff's, NRC staff's set of interrogatories to the licensees concerning Questions 1 and 2, dated June 3rd, 1982.

Interrogatory Number 7 states, "Provide a discussion of actions taken thus far to lessen the probability and or severity of pressurized thermal shock events."

And the first paragraph of that response under Unit 2 states, "A low leakage loading pattern is being incorporated. (Previously burned fuel assemblies will be selectively loaded at peripheral locations of the reactor core.) This design will be incorporate in Cycle) with the anticipated fuel loading in the latter part of 1982. This is expected to result in a significant n fluence reduction, thus reducing the effects of radiation upon the reactor vessel materials."

And later in that response, under the heading Unit 3, the following paragraph appears: "Additionally, the present fuel cycle incorporates a modified low leakage loading pattern which will result in a reduction of the fast neutron flux in the periphery of the core with the subsequent effect of decreasing embrittlement of the reactor vessel walls."

Do either of you recall reviewing those responses to the staff interrogatories?

A (WITNESS WOODS) I do not.

A (WITNESS KLECKER) I do not, either. I am not familiar with that.

Q All right. Now, have either of you reviewed the reload packages that were submitted by Con Edison and the Power Authority for the most recent reloads?

A (WITNESS WOODS) I have not.

A (WITNESS KLECKER) No.

Q All right. Now, assuming that in the case of Unit 2, such a low leakage fuel management policy has been implemented pursuant to the answer in the interrogatory that I just read, and assuming that a flux reduction of 40 percent has been achieved by that implementation, would that be sufficient to achieve a flux reduction factor of 1.4?

A (WITNESS WOODS) I am not sure you put in enough assumings, but certainly if we participated jointly in a review of what you have done and could agree that you have achieved the necessary flux reductions, then we'd be agreeing, you would be expected to stabilize the screening criteria through plant life.

Q Well, let me ask, is the reason you have not reviewed the submittals the fact that you are reviewing first the plants that have a higher PTS risk in your judgment than Indian Point?

A (WITNESS WOODS) Thank you very much. I was wondering how to work that in. That is exactly the case.

MR. SOHINKI: Mr. Chairman, may I ask the

Board's permission that Con Edison might submit an affidavit confirming what I have just read from the interrogatories, that in fact we have submitted or implemented such a load leakage policy? These witnesses have not reviewed the most recent submittals.

JUDGE GLEASON: I think that would be the subject of cross examination if you tried to put it in.

MR. BLUM: Well, in general, I think the Board before has rejected the idea of affidavits coming in without cross examination. It would be improper.

JUDGE GLEASON: That is right. It would be improper.

MR. COLARULLI: Your Honor, if I could suggest a possible alternative, I believe this has happened on one or two other occasions to questions that Judge Shon has raised. Would the Board be willing to simply direct staff to ascertain whether or not these programs have been instituted at the units, since they directly affect Board Question 1.4?

(Whereupon, the Board conferred.)

MR. MC GURREN: Your Honor, may I make a statement? I think firstly if the question concerns interrogatories, they were stated under oath, that the question is whether or not the applicant made a submittal. I think that is something they could assure the Board either here and now or by letter.

As the staff indicates in its testimony, it is conducting a review on a generic basis of many plants. Indian Point might not be reviewed for -- I don't know. We could ask the witnesses. But might not be reviewed or need to be reviewed for years.

JUDGE GLEASON: Well, as Judge Shon points out, there are statements in this testimony that indicate if certain things are done, why it provides a better degree of safety, and in effect, as I understand the testimony, licensees say in effect that they have done that.

Now, we have, I think, pending at least one other thing, perhaps two items, that we have asked about which we would generally term additional amendments, additional work done with the IPPSS matter, and we have asked, because we feel it is our responsibility, before the door closes on this hearing, to bring up to date the latest developments with respect to what is happening with these plants and these facilities.

However, we are just not going to receive this. I think it would be unfair to receive this in the form of affidavits.

We would ask, if you want to present that information, you present it with a witness. That witness will be subject to cross examination at that time, and I am sure Mr. Blum would not disagree with that. So that is the way you should do that. And that also applies to that letter of February 4th that you sent to the director of Nuclear Reactor.

MR. COLARULLI: Thank you, Your Honor.

MR. SOHINKI: I think I have no further questions, Mr. Chairman.

MR. COLARULLI: The Power Authority has no additional questions.

JUDGE GLEASON: Any redirect?

MR. MC GURREN: No redirect, Your Honor.

JUDGE GLEASON: All right, gentlemen. You are excused. I am sorry.

WITNESS WOODS: We were almost gone.

JUDGE SHON: I have, I think, about two or three quite short questions. Mr. Blum asked you about what happens in the case of spurious initiation of the ECCS, and unless I am mistaken, you replied, in effect, that is really no worry. The operator will shut off the ECCS. As soon as he sees the pressurizer filling up, that is what he will do. He will know it is a spurious initiation. Are we putting ourselves in the hands of those friendly folks who brought us TMI 2? Isn't that exactly what happened there, and didn't it get them in trouble?

WITNESS KLECKER: My statement was based on the history to date in these events. In general, that is what has happened. They realized it was a spurious event, and they did terminate it.

JUDGE SHON: But there is a certain chance in trying to duck away from a pressurized thermal shock event in this case. You might be led into doing the wrong thing in a small break LOCA. Is that right?

WITNESS KLECKER: Well, there are other indications of what is going on in the primary system, such as temperature and pressure, which information is available to the operator. In the event of a small break LOCA, of course, the pressure and temperature would decrease significantly, and I think he would have to verify to himself that it is prudent to shut off ECCS under situations like that, which is somewhat different than, say, a spurious signal where the vessel temperature remains at roughly 500 to 550 degrees.

JUDGE SHON: He has to recognize that a spurious --

WITNESS KLECKER: That is correct.

WITNESS WOODS: May I contribute to that?

JUDGE SHON: Yes, of course.

WITNESS WOODS: A spurious safety injection implies that the safety injection came on for no real reason, and it is injecting cold water, and so forth. That isn't really a severe pressurized thermal shock event, simply because you cannot put that much water in a system that is almost full already. In order to get a severe pressurized thermal shock event, you have to have some way for that water to go back out of the system so that you can supply much larger volumes of cold water, in other words, a small break.

So, the safety injection that goes along with either -- well, primarily with a small break loss of coolant accident is the significant type of safety injection. Just turning on those pumps and filling the system the rest of the way up is not enough cold water to cause a severe pressurized thermal shock event.

JUDGE SHON: Now it sounds as if you are saying to me that in the event of a small break LOCA you could get enough water in to cause a pressurized thermal shock, and therefore he shouldn't shut the pumps off, or if he doesn't shut the pumps off, that might give you trouble.

WITNESS WOODS: You have hit on one of the most -- one of the things that is considered most carefully and one of the largest quandaries that we find ourselves in. You are exactly correct. You have to avoid overcooling the vessel while you cool the core. You have a pathway that you have to stay within.

JUDGE SHON: So we do have a dilemma whose horns are pressurized thermal shock and small break LOCA, or something like that. Is that right?

WITNESS WOODS: That is correct.

JUDGE SHON: On Page 5 of your testimony, there seems a minor inconsistency to me. You are discussing the specimens and the capsules that have been withdrawn and are being tested. You say that the capsules are in the process of being analyzed, in the middle of the answer to Question 8, and then in the next sentence you say, "The results of these analyses confirm the staff calculations."

If they are in the process of being analyzed, how do you know that they confirm your calculations?

WITNESS KLECKER: In addition to the initial RT_{NDT} determinations, the specimens that I mentioned earlier, there are also specimens withdrawn from the reactors periodically, and what we are referring to in these statements here are those particular specimens where you measured a change in RT_{NDT}.

JUDGE SHON: Yes, I recognize that, but what you are saying is, you are only getting around to analyzing them and yet they have already confirmed the calculations that were predicted.

WITNESS KLECKER: Well, we may have avoided engineering problems here. It says, the specimens in the capsules from Indian Point 2 have been analyzed, and the specimens in one of the capsules from Indian Point 3 have been analyzed, and then there are others that at least we have not got the results of the analysis yet. But based on the information that we have available to us to date, I think our conclusion is all right.

JUDGE SHON: So what you are saying is, you feel you have enough data even though they have not completely been analyzed.

WITNESS KLECKER: That is right, and then there will be future specimens withdrawn also to be analyzed.

JUDGE SHON: There is, of course, no way of determining RT_{NDT} in an existing weld during the lifetime of the reactor. Isn't that right?

WITNESS KLECKER: There is no practical way.

JUDGE SHON: Fine. The last question concerns a point on Page 9 in your Answer 13. You mentioned in the cross examination a little earlier that your examination for cracks and ultrasonic examination for crack size and that sort of thing takes place every ten years. I notice that you say that the RT_{NDT} values increase approximately seven degrees Fahrenheit per year. After ten years from that same answer at least one of them would have passed its screening value.

Is every ten years on the crack testing sufficient if the thing can pass its RT_{NDT} screening value in less than ten years?

WITNESS KLECKER: I think both Indian Point units have more than ten years before they approach the screening time.

JUDGE SHON: You said one of them was fifty-eight degrees. I think it is Unit 3. Below. And it is going seven degrees per year. Seven times ten is seventy, and that is more than fifty-eight, unless arithmetic has changed.

WITNESS KLECKER: The number is seven -- let's see. Well, I think that it does not necessarily apply to all facilities. The number is based on Indian Point 3, where you have fifty-eight degrees yet to go. The numbers I have would say they would not reach the screening criteria before the year 2000, so they are actually increasing at a lesser rate.

WITNESS WOODS: I believe the relevant thing here is, when the plants are operating at 100 percent power, of course, they don't operate at 100 percent power for the entire year, so there is a reduction factor there.

JUDGE SHON: So what you are saying is, it is seven degrees per equivalent full power year.

WITNESS WOODS: I believe that is so.

WITNESS KLECKER: It does vary from facility to facility, depending on core loading.

JUDGE SHON: But the statement says, when these plants are operating.

JUDGE PARIS: We need to know whether the seven degrees applies to Indian Point or not. It seems to say it does in the testimony, but you seemed to say just now it didn't.

WITNESS KLECKER: I don't have it in terms of rate. I would have them going 58 degrees in 15.6 years, if someone could make the division to get the rate.

JUDGE SHON: I notice also that you mention in that same answer in the next paragraph that the PTS risk decreases an order of magnitude for each approximately 40 degrees Fahrenheit reduction in RT_{NDT}. I presume that it also increases an order of magnitude for each 40 degree increase in RT_{NDT}.

WITNESS KLECKER: Yes. This is approximately correct in the range of concern, say, of about 270. Of course, if you push it to 500 degrees or something like that, and of course it is a non-linear effect.

JUDGE SHON: So that again if this thing increases seven degrees per year, every ten years or so you have gone up a couple of orders of magnitude, it seems. That is quite a bit.

WITNESS KLECKER: Which is one of the reasons we are suggesting looking at flux reduction methods at this time.

JUDGE SHON: And of course the licensee has hinted that there are flux reduction processes in progress.

WITNESS KLECKER: We understand that.

JUDGE SHON: I might ask you one more thing. When one reduces the flux by going to a low leakage core, what effect does that have, do you have any idea what effect that has on the cost of operating the plant or the cost of production of electricity? Does it make it cost more or less?

WITNESS KLECKER: It depends on the specific amount of flux reduction. As we understand it, by going to a low leakage core, there is no penalty economic-wise. If they have to go to, say, larger flux reductions, such as putting stainless steel elements in the periphery, then definitely that gets to be expensive.

WITNESS WOODS: It depends on the degree of flux reduction you want, and it depends very highly on the particular plant that you are dealing with. In general, flux reductions on the order of a factor of two are not terribly expensive. When you want to go beyond that, they can get very expensive, but that is a general answer that might not apply to a given plant. We have not specifically looked at Indian Point.

JUDGE SHON: Thank you. That is the sort of thing I wanted. It is evident that if you try to reduce your flux by a factor of two by simply reducing power level, it would be expensive.

I think Judge Paris has a question.

JUDGE GLEASON: I just want to make sure that -- I did the calculation, based on the figures you gave us, that in -- well, I calculated it on the basis of 15.8 years. Is that what you said?

WITNESS KLECKER: I said 15.6.

JUDGE PARIS: 15.6 years. It doesn't make much difference. I came out with a figure of an increase of between three and four degrees per year, and what I would like to get clear is whether the increase based on the figures that you gave us is lower than the increase of seven degrees per year given in your testimony. Does that result from the fact that the plants don't operate at full power for a year?

WITNESS KLECKER: It depends also on the location of the critical weld in the vessel, which is the one we usually address when we look at these particular figures, and the rate of seven degrees, I believe, is a good average, say, across the board for most pressurized water reactors. It can be plus or minus from that depending on the specific core.

If the peak flux in the vessel or that hits the vessel wall is at a critical weld, for instance, it could be considerably higher than, say, seven degrees, but if, on the other hand, the critical weld in the vessel, that is, the weld with the highest copper content, for instance, is in a low fluence region, then it could be the other way around.

JUDGE SHON: You know, can either one of you give us a real number for the rise in RT_{NDT} at Indian Point's critical weld, considering its copper content and everything else, per equivalent full power year and per year, taking account of what the operating history was or is expected to be as far as capacity factor?

WITNESS WOODS: We cannot do that. We suffer from the fact that there is a very large task force that works on pressurized thermal shock, and we simply didn't provide all of them as witnesses, and the particular materials expert -- actually, there are two people who participated in this who are not here.

JUDGE SHON: So that this number, seven degrees per year, really is not a number on which we as a Board could rely. It could be as low as 3-1/2 degrees a year, it could be very different because of a low-leakage core that is now installed. You just don't know what it is.

WITNESS WOODS: That is correct, I don't know what it is.

JUDGE PARIS: Do you think there's anyone on the Staff who knows what it is?

WITNESS WOODS: Yes, I do, but he's not here. There are two different people. One person is an expert on fluence calculations and the determination of fluence and so forth, and that information has to be factored in to our materials expert, who converts that into material property, RT_{NDT}. And we need to confer with both of them to give you a definable amount.

JUDGE GLEASON: Would the Staff please have that information provided to us, if possible, at the time the Licensees come before us with their witness with what work they're doing in this area?

MR. McGURREN: Let me make sure I understand, Your Honor. Are you asking the Staff to present witnesses on this point?

JUDGE GLEASON: I'm not asking you to present a witness. I'm asking you to present the numbers that Mr. Shon and Dr. Paris have asked about.

MR. McGURREN: We will do so, Your Honor.

MR. BLUM: We would like the ability to cross-examine.

JUDGE GLEASON: I understand what you would like, but I'm saying we're going to ask for that information.

MR. McGURREN: Your Honor, I think we should find out. Maybe these witnesses know if that exact number presumes a thorough analysis of the core --

JUDGE GLEASON: Does this require a lot of detailed work?

WITNESS WOODS: Yes. If you want the number to reflect the flux reduction that I've heard about here today, it would have to be rather thoroughly reviewed befor we would want to give you a number we would swear to under oath.

JUDGE GLEASON: I don't mind the thorough review. It's always helpful to have it. All I'm asking is how much work is involved.

WITNESS WOODS: I'm hesitating to answer because it is not my work and it is not my area. I would like to ask the people I just referred to how much of an effort it would be. I don't know.

WITNESS KLECKER: It would depend on submissions from the Licensees. While we don't know what you have already submitted, maybe it has been. But if it hasn't, it would have to come from you.

JUDGE SHON: You can't do it on the basis of what you were told in the hall.

WITNESS WOODS: No, certainly we would not do that.

(Pause.)

WITNESS WOODS: What we are basically discussing is when the schedule is for doing the plant-specific analysis -- whether or not it's 10 years away or 15 years away or only 8 years away. And it's up to you to judge how relevant that is. That's what we're discussing here.

JUDGE SHON: I guess what we are concerned about now is, it seems to me at least that neutron fluence is not something like apples, that you can look at and count with your fingers. Neither is the rate of rise of RT_{NDT} as a function of neutron fluence and copper content and the previous heat and temperature treatment and things on this order.

WITNESS WOODS: I certainly agree with both of those statements, yes.

JUDGE SHON: So for someone to say it rises X degrees per year implies that that someone has used an awful lot of formulas and made an awful lot of estimations about how neutrons get out of reactors and about how metalurgical changes take place and radiation damage occurs and things like that.

It is not something he can look at and say, yes, I saw it and it was six feet tall; is this correct?

WITNESS WOODS: That is correct.

JUDGE SHON: I guess, then, we would need a witness who knew exactly how these estimates were made and how reliable they were, would we not?

WITNESS WOODS: But the point is that the witness would be only addressing the schedule for the plant-specific analyses which would tell you what the real risk is at Indian Point, and in any case that would be presented before they exceed the screening criteria.

JUDGE SHON: Before what?

WITNESS WOODS: Before the plant exceeds the screening criteria.

(Board conferring.)

JUDGE GLEASON: Mr. McGurren, I think the Board, in light of the volume of work that is involved in this kind of request, would be best served if we could have a witness from the NRC who would be competent enough to talk about the work that the Licensees have been doing and are doing at the time that they produce their witness. So if you could coordinate that.

WITNESS WOODS: Could I comment on that?

JUDGE GLEASON: Yes.

WITNESS WOODS: I guess witnesses aren't allowed to object, but I would like to comment that there aren't that many people within NRC who are capable of doing that, and the people who are capable of doing that are working right now --

JUDGE GLEASON: It is contractor work, is that what you're saying?

WITNESS WOODS: No, they're within the NRC and these people are actively pursuing the plants that are above Indian Point on this list, and I don't think it is in the best interest of the safety of the nation to take the people off of that work and put them on Indian Point.

JUDGE GLEASON: Well, we have a safety question that's very important in this hearing.

MR. McGURREN: Mr. Chairman.

JUDGE GLEASON: Yes.

MR. McGURREN: Maybe we can put this in some sort of frame of reference. As I understand these witnesses' testimony, they are saying that there are certain reactors that are sort of ahead of Indian Point in terms of need for review or at least concern about review, and those individual plants are submitting data for the NRC Staff to do its review.

Their testimony says that Indian Point 2 and 3 are somewhat behind them and that therefore we're concerned about them, but we're not concerned about them in terms of acceptable operation.

WITNESS WOODS: In fact, the Commission directed that plants in the category where flux reduction factor of two to five would exceed the screening criteria, and this plant is not in that category. So we have not up to this point been asked to look at this plant right now.

JUDGE SHON: You're testimony says that at least one of these plants would require a factor of 1.9. That is certainly a number that is pretty close to two.

WITNESS WOODS: Well, it appears to be so, sir. But if they really have done the flux reduction that we are hearing about, then it really isn't that high. You have to draw the line somewhere and we draw it at 2.0.

JUDGE GLEASON: Well, all right. We'll be not satisfied, but we will see what the Licensees have to say with their witness and we'll see if there's anything else we have to go on from that point on.

MR. McGURREN: Thank you, Your Honor.

JUDGE GLEASON: The witnesses are excused.

(Witnesses excused.)

JUDGE GLEASON: How are you going to handle the next? You have two witnesses left. Do you want to put them both on the stand at once?

MR. McGURREN: Some of their testimony is joint testimony. There are two pieces that are single pieces. I would suggest that I will put in two of the joint pieces and one of the single pieces right now, and that after Mr. Blond is excused I'll put in the last single piece, if that's all right with the Board.

JUDGE GLEASON: That's fine with the Board.

I think now that you're up there we're going to take a five-minute break. Is that all right, Ms. Moore?

We'll take a five-minute break.

(Whereupon, at 10:50 a.m., the hearing in the above-entitled matter was recessed, to reconvene at 10:55 a.m.)

11:02 a.m.)

JUDGE GLEASON: Let's proceed, please.

MR. McGURREN: Your Honor, the Staff calls Frank H. Rowsome and Roger Blond.

JUDGE GLEASON: All right, let's proceed, please.

MR. McGURREN: Mr. Chairman, these gentlemen have already been identified for the record on several occasions.

JUDGE GLEASON: Numerous occasions.

Whereupon,

FRANK H. ROWSOME III

and ROGER M. BLOND,

recalled as witnesses by counsel for the Regulatory Staff, having previouslybeen duly sworn by the Chairman, were examined and testified as follows:

DIRECT EXAMINATION ON BEHALF

OF THE REGULATORY STAFF

BY MS. MOORE:

Q Gentlemen, do you have before you a document entitled "Direct Testimony of Roger M. Blond and Frank H. Rowsome, Summary Response to Commission Question Posed to the Board"?

A (WITNESS ROWSOME) I do.

Q Was this testimony prepared by you or did you participate in its preparation?

A (WITNESS BLOND) Yes.

A (WITNESS ROWSOME) Yes.

Q Do you have any additions or corrections to this testimony?

A (WITNESS ROWSOME) Yes, a few minor ones.

On page 4, the second line now reads -- well, let's see. I'd like to put in after "necessary" the following phrse: "for this accident sequence".

JUDGE GLEASON: Excuse me. Page 4?

WITNESS ROWSOME: I'm sorry, page 5, line 2, near the very top.

JUDGE GLEASON: What is the correction again?

WITNESS ROWSOME: Caret in between the words "necessary" and "to" the following phrase: "for this accident sequence".

JUDGE GLEASON: Okay.

WITNESS ROWSOME: Page 6, line 2,, "Buchbinder" is misspelled. It should be B-u-c-h-b-i-n-d-e-r", comma. Following "Buchbinder" is a comma.

And then the fifth line that starts, "Unit 3 has been modified", should read "Unit 3 is being modified".

Three lines from the bottom now reads "change due to the fix was in reducing the probability of the C damage state". It should be "C release category".

JUDGE PARIS: "Release category" replaces "damage state"?

WITNESS ROWSOME: That is correct.

Page 7, answer 10, first big paragraph, about a third of the way down the page. The middle line of that paragraph now reads, "ciation" -- continuation of "appreciation" from the line above -- "for the relationship of intend-external events". It should read "internal-external events".

In that same paragraph, next to the last line now reads "are very important to risk". There should be a period after "risk" there. Delete the following word, "perspectives", capitalize the "t" in the next word, "they".

Page 8, very bottom line on the page, now reads, "Category C, caused by earthquakes and hurricanes". Caret in "fires" ahead of "earthquakes" and put in a comma, so it now reads, "Category C, caused by fires, earthquakes and hurricanes".

Page 9, near the bottom there is a subheading that says "Early fatalities". The first line following that, delete the word "the", the second word in the line, and after "most" caret in "of the". So the beginning of that sentence reads, "For most of the severe accidents".

Page 11, bottom paragraph, third line, "model" is misspelled, m-o-d-e-l.

That completes the corrections.

BY MS. MOORE: (Resuming)

Q With these changes to your testimony, is it true and correct to the best of your knowledge, information and belief?

A (WITNESS ROWSOME) Yes.

A (WITNESS BLOND) Yes.

Q Do you adopt this as your testimony in this proceeding?

A (WITNESS ROWSOME) Yes.

A (WITNESS BLOND) Yes.

MS. MOORE: Copies of this testimony have been delivered to the Board, the parties, and the court reporter. I ask that this testimony be admitted into evidence and bound into the record as if read.

JUDGE GLEASON: Is there objection?

Hearing none, the testimony will be received into evidence and bound into the record as if read.

(The document referred to, the prepared testimony of Messrs. Rowsome and Blond, received in evidence, follows.)

#1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSOLIDATED EDISON OF NEW YORK (Indian Point, Unit 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit 3)	Docket Nos. 50-247-SP 50-286-SP

DIRECT TESTIMONY OF ROGER M. BLOND AND FRANK H. ROWSOME
SUMMARY RESPONSE TO COMMISSION QUESTION POSED TO THE BOARD

IV.A. CONCLUSION

Summary Response to Commission Questions Posed to the Board:

What risk is posed by severe reactor accidents at IP 2/3 as they are currently designed and operated?

Q.1 Please state your name and your position with the NRC.

A.1 My name is Roger M. Blond. I am Section Leader for the Accident Risk Section of the Reactor Risk Branch of the Division of Risk Analysis of the Office of Research.

Q.2 What are your responsibilities in that position?

A.2 I am responsible for providing technical and managerial direction in developing methods and research in accident risk analysis and in performing applications in risk assessment.

Q.3 Have you prepared the statement of your professional qualifications?

A.3 Yes, the statement of my professional qualifications is attached to this testimony.

Q.4 Please state your name and your position with the NRC.

A.4 My name is Frank H. Rowsome. I am Deputy Director of the Division of Risk Analysis in the Office of Nuclear Reactor Research.

Q.5 What are your responsibilities in that position?

A.5 I assist the Director in planning and managing the research group in risk assessment, probabilistic safety analysis, operations, research, reliability engineering, and related regulatory standards development.

Q.6 Have you prepared a statement of your professional qualifications?

A.6 Yes, the statement of my professional qualifications is attached to this testimony.

Q.7 What is the purpose of your testimony?

A.7 The purpose of my testimony is to summarize the staff's testimony on the risk at Indian Point to respond to the Commission questions. As was discussed in the introductory material, reactor accident risks can be described in different ways. Risk can be represented by one number which is calculated as a simple summation of the accident probabilities times the associated consequences; this one number is generally referred to as the expected risk. Risk can also be represented by a curve relating probability to exceeding a given level of consequence; this curve is known as the Complementary Cumulative Distribution Function (CCDF). Appendix A of NUREG-0715 describes how such figures are constructed. In addition, risk can be represented by the level of uncertainty associated with the probability and consequence estimates; as was done in the Indian Point Probabilistic Safety Study. Common to all of these definitions of risk is the concept of accident probability and consequence. S. Israel, R. Budnitz, and B. Buchbinder in Section III.A described accident probabilities; J. Meyer in Section III.B described the approaches and assumptions used to generate the magnitude and characteristics of the radioactive release to the atmosphere; and S. Acharya in Section III.C described the calculations associated with the consequence estimates. Building upon each section, the probabilities and consequences are generated for seven different risk measures. These are early fatalities (occurring within a year after exposure); early injury; delayed or latent cancer fatality; thyroid cancer; genetic effects; offsite property damage costs; and land contamination. In addition, perspectives are given on the individual as well as the societal risks.

Probabilistic risk assessment attempts to provide the relationship between the probabilities of the accidents and the consequences. To presume a release occurs without accounting for its likelihood is a misrepresentation of risk. It is possible to contrive scenarios by which most of the radioactive material could be released to the atmosphere and would be transported to the most populous location where it could do the most harm. However, the chance of this realistically occurring has to be factored into the analysis. This realistic analysis is the objective of probabilistic risk assessment.

Q.8 You defined risk as probabilities and consequences, what is included in the probability portion of risk?

A.8 The probability portion of risk includes the probabilities associated with the accident sequence occurrence, and the probabilities associated with the magnitude of the radioactive material released to the environment, and the probabilities associated with the magnitude of the consequences.

Q.6 What is included in the probabilities associated with the accident occurrence?

A.6 There are several factors which go into making up estimates of the probabilities of potential accidents. These factors are given in the following formula:

$$P_{accident} = P_{initiator} \times P_{system\ failures} \times P_{containment\ failure}$$

where $P_{accident}$ is the probability of the accident, $P_{initiator}$ is the probability of the initiating event or damage state, $P_{system\ failures}$ is the probability of a sequence of systems failures, and $P_{containment\ failure}$ is the probability of the containment failure.

This then defines a sequence of events in terms of probabilities--starting from the initial accident cause and working through the systems and containment response. There is thus a dependence in moving from one factor to the next.

For example, one of the more probable severe accident sequence at either Indian Point unit prior to the recent fixes was caused by a fire which fails a pump seal causing a small-break loss-of-coolant accident. The fire simultaneously affects other safety and containment systems. Thus, the fire prevents the emergency core cooling systems from operating and this leads to core melt. The fire also disables the containment heat removal systems. In terms of the above equation, $P_{initiator}$ is the fire, considered an external common cause failure, causing a small-break loss-of-coolant accident. The probability of such an event was assessed by the IPPSS to be about 2×10^{-4} per reactor year for Unit 2. $P_{system\ failure}$ and $P_{containment\ failure}$ are both assumed to be 1.0 given that the fire occurs. Therefore, the probability associated with this accident occurrence is $2 \times 10^{-4} \times 1.0 \times 1.0$ which equals two chances in ten thousand per reactor year for Unit 2.

Q.7 What is included in the probabilities associated with the magnitude of the radioactive material released to the environment?

A.7 The probabilities associated with the magnitudes of the radioactive material released to the environment are currently assumed to be synonymous with the probabilities associated with the specific containment failure mechanisms. If the containment fails by overpressurization--large amounts of radioactive materials can be released; however, if the containment fails by basemat melt-through--relatively little radioactive material would be released via the atmosphere.

Moving along with the above example, we have already assumed containment failure with a probability of 1.0. However, even assuming no containment heat removal, according to the Section III.B there is about a 60% chance that the containment fails by basemat melt-through, and about a 40% chance that the containment fails by late overpressurization. Containment overpressurization is necessary to have the potential for a large release. Thus the probability associated with this accident having a large release of radioactive material directly to the atmosphere is $2 \times 10^{-4} \times 0.4$ which equals 8×10^{-5}.

Q.8 What is included in the probability associated with the magnitude of the consequences?

A.8 The probability associated with the magnitudes of the consequences includes the probabilities associated with the following kinds of factors: weather conditions, numbers of people exposed (wind direction), emergency response, and health effects given exposure. If there is a 10 percent chance that the wind blows the radioactive material in a direction where there are no people given the accident, then the absolute probability associated with no health effect consequences from the above example is $8 \times 10^{-5} \times 0.1$ which equals 8×10^{-6} per reactor year. This combination of probability and consequence (8×10^{-6} and 0) represents one potential point of the risk at Indian Point.

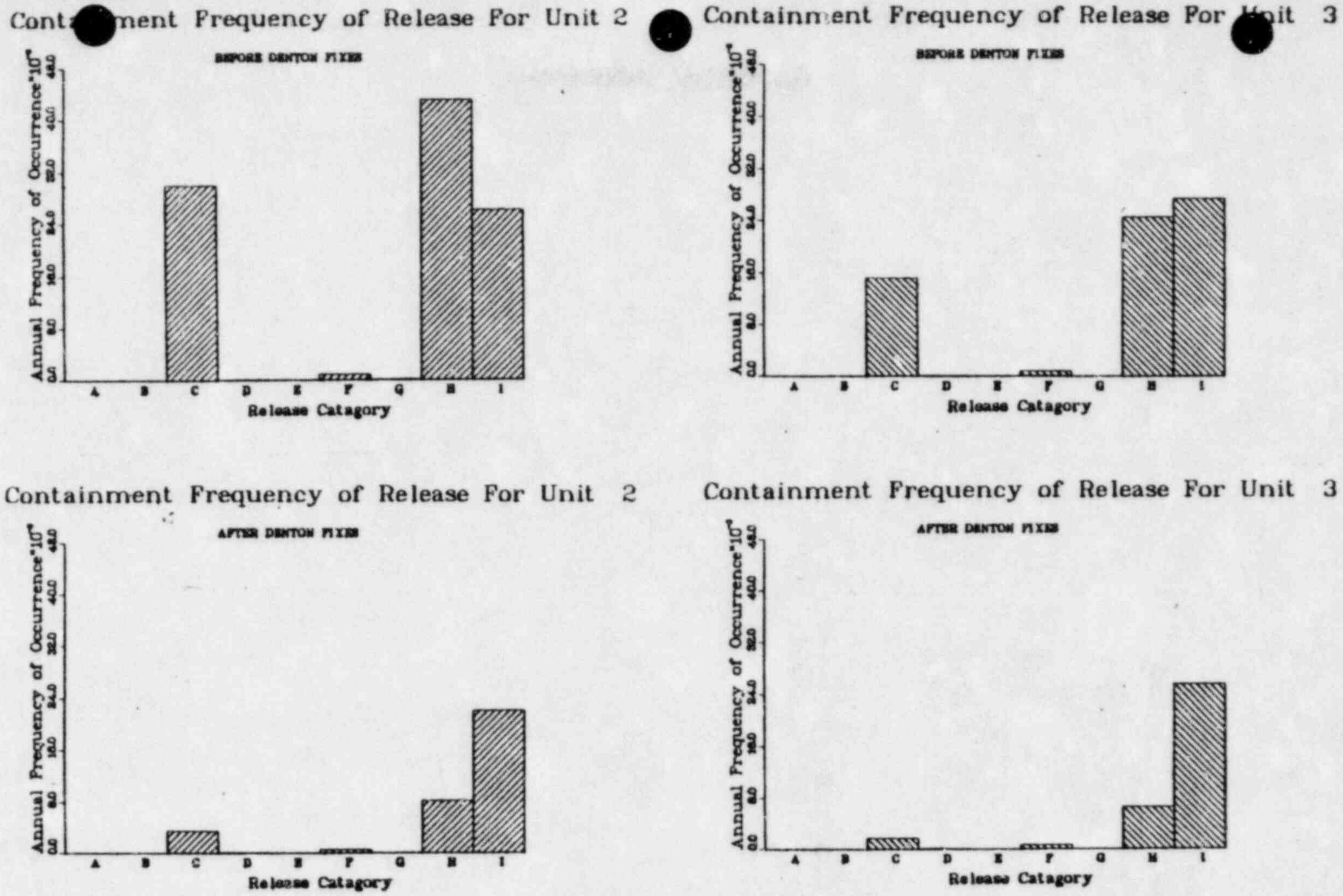
Q.9 For the Indian Point plants, what is the relationship between the accident probabilities and the potential release of radioactive material?

A.9 As has been explained in previous testimony, there is a spectrum of accident releases postulated for the Indian Point reactors. This spectrum ranges from accidents like the Release Category I event (given in Table III.C.3) which would release very small fractions of the radioactive material, to accidents like the Release Category A event which would release very large fractions of radioactive material. For the Release Category I event, there are little or no public health and safety consequences, whereas for the A release the consequences could be very severe.

Based upon the Indian Point Probabilistic Safety Study (with Sandia National Labs and staff refinements as described in III.A), a set of probabilities were derived for each of the damage states. These probabilities, shown in Table III.B.1 under the "Before Fix" columns, represent the plants as analyzed circa 1981. As explained in the testimony of Messrs. Bookbinder Budnitz, and Rowsome Unit 2 has now been modified to reduce the seismic fragility, reduce the fire vulnerability and develop procedures to shutdown for severe hurricanes; in addition, Unit 3 has been modified to reduce fire vulnerability. To reflect these modifications, new probabilities of the damage states are shown in Table III.B.1 under the "After Fix" Columns.

Figure IV.A.1 summarizes the analyses for both before and after fix and shows the three dominant accident sequence/containment failure categories. For either unit the most probable accidents, given that a core melt occurs, is either the case in which the containment holds, Release Category I, or there is an eventual release through the containment basemat, Release Category H. For both of these accidents there is minimal offsite health and safety impact. There would not be any early health effects and contamination levels would be so low that emergency response would probably not be mandated under current Environmental Protection Agency protective action guideline dose projection recommendations. The only significant accident probability scenario with a large release/consequence potential is the long-term overpressurization category, C. Even though there is the potential for large releases, there would be significant warning times (at least 8 hours) for the public to take protective measures. Large release scenarios which will occur quickly such as categories A and B have only about one chance in a thousand of occurring given a core melt occurs. Thus, the risk importance of these scenarios is significantly reduced.

Comparing the "Before Fix" to "After Fix" charts reveals that the major change due to the fix was in reducing the probability of the C damage state. This is due to the emphasis on external events which dominate the risk.



Release Category	Failure Mode
A	Large seismic event β^* (containment collapse)
B	Event $\bar{V}$ and all α (alpha) failure modes
C	All long-term δ (delta) overpressurizations and SGTR event
D	All early γ (gamma) hydrogen burns (no sprays)
E	All late γ (gamma) hydrogen burns (no sprays)
F	All early γ (gamma) hydrogen burns (with sprays)
G	All β (beta) failure modes (failure to isolate containment)
H	All ε (epsilon) basemat penetration modes
I	All conditions for which containment failure does not occur.

Figure IV.A.1 Release Category Contribution To Probability of Core Melt

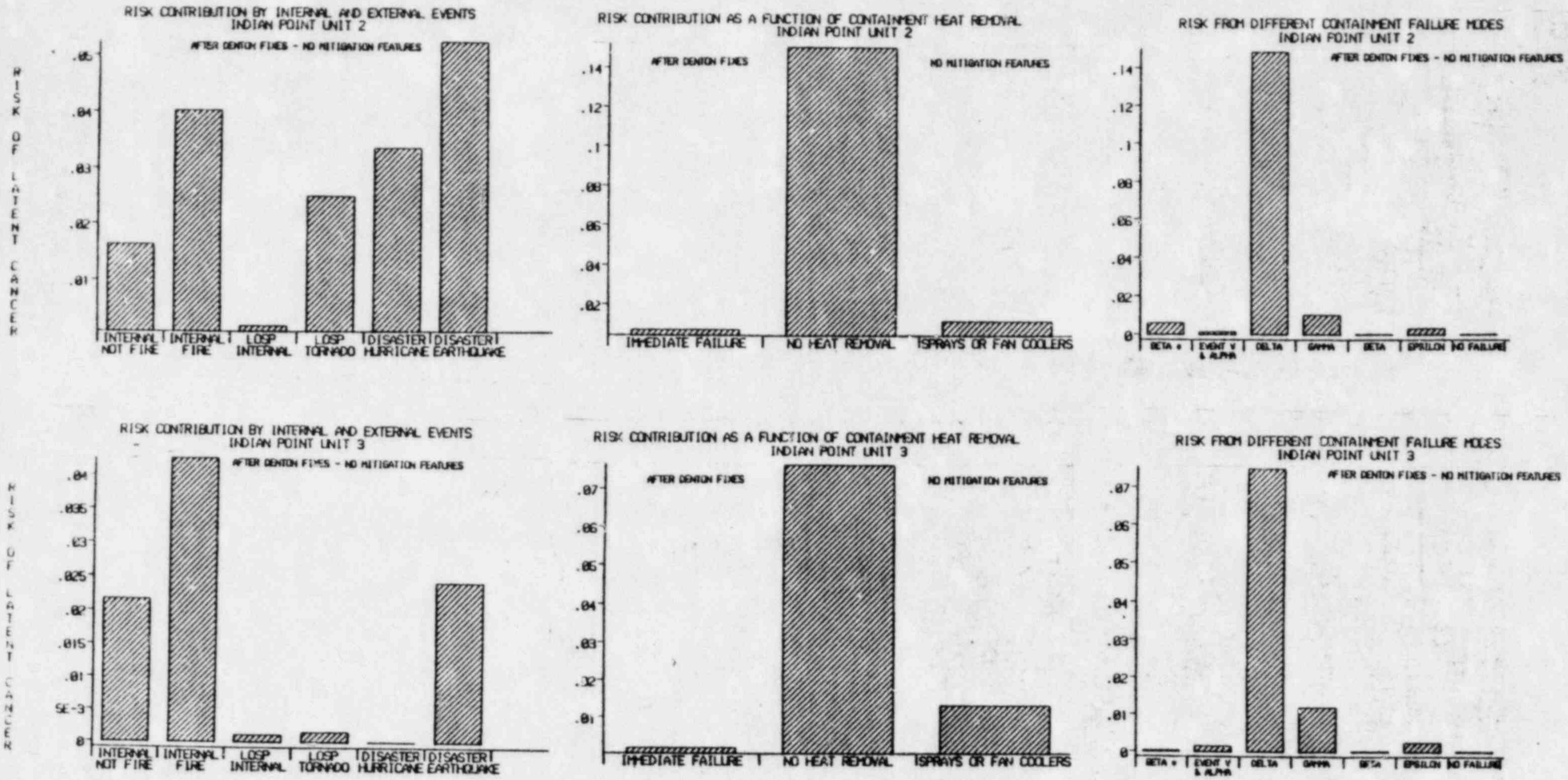
Q.10 How do the accident probabilities and release magnitudes relate to the risk at Indian Point?

A.10 A perspective on the accident initiators will provide insights into the initial conditions which will be expected in the reactor systems.

More than 90 percent of the risk comes from small-break loss-of-coolant accidents. Transients and large-break loss-of-coolant accidents have very little risk significance at Indian Point. It should be noted, however, that transients would cause small breaks in the pump seals. These small breaks are a dominant contributor to risk. These transient-induced loss-of-coolant accidents are counted as small break events. To gain an appreciation for the relationship of intend/external events, containment heat removal and containment failure to the Indian Point plants, a set of bar chart figures are given below. An appreciation for the importance associated with internally versus externally caused accidents is shown in Figure IV.A.2.a. For Indian Point, seismic events, fires and hurricanes are very important to the risk perspectives they pose far more risk than the internal initiators.

The second factor in the accident probability formula is the probability of system failure. This is a very important term in the equation for it can give insight into potential system importances which can influence accident prevention. System interactions are also investigated at this stage of the analysis. In addition, human failures as well as machine hardware failures are considered. In the risk model, the human error contribution is treated as an integral part of the failure analysis and cannot easily be broken into its component parts.

The third factor in the accident probability formula is the containment failure probability. Figure IV.A.2.b displays the contribution of containment heat removal to the risk. For the Indian Point containments, both the containment sprays and the fan coolers must fail in order to fail the containment directly to the atmosphere. As such, if either system is operable, the risk is very small. The last column on the chart, Figure



CONTAINMENT FAILURE MODES

β* - SEISMIC INDUCED
V - CHECK VALUE
α - STEAM EXPLOSION
δ - OVERPRESSURE
γ - HYDROGEN
β - INTEGRITY
ε - MELT THROUGH

Figure IV.A.2 Relationship of Indian Point Units 2 and 3 to Accident Risk (Latent Cancer Fatalities)

IV.A.2.c, shows the contribution of containment failure mode to risk. The dominant risk containment failure mode is by containment overpressurization.

The following perspective on the Indian Point designs should now be apparent. Risk is dominated by small LOCAs, from external common cause events, where no containment heat removal is possible, and the containment fails by overpressurization. This picture is representative of the Indian Point power plants as analyzed in the IPPSS. Other designs would probably have significantly different dominant accident characteristics. With this description of the plants vulnerabilities, the question of the risk at Indian Point can now be addressed.

Q.11 What is the expected risk at Indian Point?

A.11 Section III.C presented a comprehensive evaluation of the risk at Indian Point. Ten risk measures are presented. Eight are relevant to health impacts and two are related to economic impacts of the accidents. Three emergency response scenarios have been analyzed which represent the expected response under various conditions and strategies. As is explained in section IV.B, the evacuation-relocation strategy is believed to be the most representative for those accidents which are not caused by regional disasters. When accidents are caused by regional disasters the late relocation strategy is believed to be the appropriate model.

It is interesting to note that if the early relocation strategy were used as the base case instead of the evacuation-relocation strategy, the results would be just about the same. Section IV.B explains why this is so. It is important to recognize that the details associated with the evacuation versus a relocation strategy will have little to do with the risk at Indian Point. Upon examination of the probabilities given in table III.C.4 and the conditional consequences given in table III.C.5 it is concluded that the risk at Indian Point is dominated by release category C caused by earthquakes and hurricanes.

Tables III.C.6 and III.C.7 give the expected risk for both Indian Point units 2 and 3 respectively.

Some general comments can be made concerning the expected risks associated with reactor accidents at Indian Point. First, the expected risk for all of the measures associated with health effects (i.e., early fatalities, early illnesses, latent cancer fatality, thyroid cancer, and genetic effects) is about one per reactor year. Second, the expected risk associated with offsite property damage is on the order of a million dollars per year from reactor accidents at Indian Point. These numbers are indicative of the risks associated with Indian Point. They include both the probability of the accidents and the associated consequences. Therefore, they represent the annual threat that the plants pose to the public.

Q.12 Explain the importance of the risk curves (complementary cumulative distribution functions) for Indian Point.

A.12 The probability/consequence relationship is very important to the concept of risk. The following sections summarize the risk curve results for the measures of risk that have been previously calculated. As discussed in the introduction, there are large uncertainties associated with the results presented. The numbers given are best estimate values and should be recognized as such.

Early Fatalities

For the most severe accidents, there is a very small probability that sufficient radiation could be released to cause potentially lethal exposures. For comparison purposes, supportive treatment will be assumed in this summary. Lethal exposures would probably be limited to a couple of miles from the reactor. However, for adverse meteorological conditions (e.g., downwind precipitation), it is possible to have very localized high concentration areas that could give lethal exposures at distances out to about 30 miles from the reactor.

As can be seen from Figures III.C.1 and III.C.12, there is a probability of about 5 x 10^{-6} and 1 x 10^{-6} associated with consequences of at least 1 early fatality caused by potential reactor accidents at Indian Point Units 2 and 3, respectively. This corresponds to the probability associated with accident sequences having large releases multiplied by the probability that the wind was blowing in a populated area while transporting sufficient radioactivity to cause lethal exposures.

Figures III.C.1 and III.C.12 also display the importance of the emergency response strategies to early fatality risk. See also Section IV.B for a discussion of the effectiveness of emergency response in terms of risk.

In addition to the emergency response considerations, another important aspect of the early fatality risk concerns the ability to provide a sufficient number of people with supportive medical treatment. Analysis of the Section III.C curves indicate that the risk of early fatality is about a factor of three higher if supportive medical treatment is not administered.

The probability associated with at least 100 fatalities in Figure III.C.1 is approximately the same as the probability associated with one fatality. This is because there are a number of weather conditions and directions (populations exposed) which will cause up to about 100 lethal exposures. The "largest" number of fatalities calculated at Indian Point Units 2 or 3 is about 30,000 to 40,000 people and has a probability associated with it of about one chance in one hundred million and one chance in a billion per reactor year for Units 2 and 3, respectively. This "largest" number of fatalities is associated with the simultaneous occurrence of the "largest" release categories, the "worst" weather conditions, the wind blowing in the direction of the "highest" population, and a very pessimistic emergency response assumption. The adjectives "largest," "worst," and "highest" are put in quotation marks to indicate that they represent the maximum values generated in the calculation. This is not to say that larger numbers could not be generated. Indeed it is conceivable to devise conditions which will increase the "maximum" somewhat, however the probabilities associated with such increases should also diminish.

Individual risk of early fatality as a function of distance is shown in Figure III.C.23. This figure gives some perspective on the risk imposed by Indian Point Units 2 and 3 as a function of distance. The important message conveyed in these figures is the very low (10^{-6} to 10^{-11}) absolute probabilities that have been projected for an individual's risk of being exposed to a lethal level of radiation.

Early Injury

The risk measure of early injury is defined to be those injuries which would have visible symptoms and would probably warrant some medical attention shortly after the accident. Types of injuries considered are prodromal vomiting, diarrhea, and respiratory impairment. Calculations indicate that for the largest releases there would be about a factor of ten more early injuries than early fatalities. In addition, even for large releases, it would be expected that early injuries would be limited to within about 10 miles of the reactor. However, for the adverse meteorological conditions, early injuries could occur out to about 50 miles. The complementary cumulative distributions functions for early injury are shown in Figures III.C.4 and III.C.15. Individual risk curves versus distance are given in Figure III.C.25.

Latent Cancer Fatality

Radiation exposures can increase the number of cancer fatalities in the exposed population. The model used to predict the increase in cancer incidence is the Reactor Safety Study modal which is similar to the linear-quadratic model recently recommended by the Biological Effectiveness of Ionizing Radiation (BEIR) III Committee of the National Academy of Sciences.

Figures III.C.6 and III.C.17 present the probability/consequence curves for latent cancer fatalities. The unique feature concerning the latent cancer fatalities is that the cancer fatalities would begin after some latency period, occur over a period of many years, and would include many different types of cancer. As such, it is not appropriate to simply add the latent cancer fatality risk to the early fatality risk which occur within the first year without accounting in some manner for this fundamental difference. However, there would be expected to be about 10 times more latent cancer fatalities than early fatalities. One technique to compare early fatalities to latent cancer fatalities which has been used in the past (i.e., WASH-1400) is to divide the total latent cancers by 30 years, which is the period during which most of the cancers will be occurring, thus generating a yearly cancer fatality rate due to the reactor accident. As such there would probably not be a statistically significant increase in the cancer fatality rates of the population at risk.

The risk to an individual of latent cancer fatality is presented in Figure III.C.26. This figure shows that there is about a two order of magnitude drop in risk from about one mile to about 50 miles from the reactor. In addition, as can be seen in the figure, emergency response assumptions (evacuation/relocation) have a minimal impact on the total latent cancer fatality risks.

Thyroid Nodules

Based upon current (WASH-1400) source term assumptions, large amounts of radioactive iodine will be released in the most severe reactor accidents. If the radioactive iodine is deposited internally in the human body, it will be concentrated preferentially in the thyroid gland. As a result, the radiation dose to the thyroid is likely to exceed the dose to the rest of the body, and thyroid damage is likely to adversely affect more individuals than any other accident-induced radiation effect. The model used in this study predicts approximately 334 thyroid nodules per million person-rem, based upon thyroid dose. Of the predicted nodules, about one-third are estimated to be cancerous. Both benign and malignant nodules can be medically treated with good success.

It has been conservatively assumed that one-tenth of the cancerous nodules would be lethal. Figures III.C.8 and III.C.19 present the probability and consequence estimates for thyroid cancer fatalities for the Indian Point reactors.

The number of thyroid nodules predicted in the largest accidents would be approximately equal to the normal annual incidence rate of thyroid nodules in the exposed population. Therefore, the largest accident would approximately double the normal incidence. This effect would probably be detectable in the population at risk.

Genetic Effects

It is believed that radiation exposure would increase the mutation rate of genetic disorders. Radiation-induced mutation would not be any different than mutations that occur in nature. The effects would include such obvious effects as albinism or they can be almost undetectable. The model used in this study assumes 260 cases of genetic abnormalities per million person-rem, based upon whole-body dose. Figures III.C.9 and III.C.20 present the Indian Point total whole-body person-rem. It is estimated that there would be an increase of about 2 percent of the background genetic abnormality rate for the most severe accidents, for the population at risk.

Property Damage

All of the preceding risk measures are related to human health impacts of potential reactor accidents. There are actions which could be taken to reduce the risk of health effects of radiological exposure. However, the actions have costs associated with them. There are five actions which could be taken to reduce the health risks. The models used in this analysis assign costs to each of these actions based upon Indian Point specific data: first, there is a cost associated with people evacuating; second, there is a cost associated with the temporary relocation of people from those contaminated areas within which projected doses for continued exposures are above acceptable levels; third, there is a cost associated with the loss of benefits from property that must be interdicted for long periods because it cannot be reasonably decontaminated; fourth, there is a cost associated with decontaminating an area; and fifth, there is a cost associated with disposing of contaminated agricultural products (i.e., dairy and crops).

To estimate the costs, criteria are needed for setting acceptable dose levels. If criteria are set at very low dose levels, the health impacts would be reduced, but the costs associated with the five actions would be very hi' . Conversely, if the acceptable dose levels are set very high, then the costs associated with the actions would be minimal, but the health impacts would increase. An 'trary acceptable dose level for relocation was chosen in the Reactor Safety Study to be 25 rem in 30 years. This value represents a tradeoff between health effects and costs. If the value were increased to 50 rem in 30 years, the expected costs would be decreased by a factor of 4; and the expected latent cancer fatalities and genetic effects would increase by about 10 percent. If the value was decreased to 10 rem in 30 years, the expected costs would increase by a factor of 2.5, and the latent cancer fatalities and genetic effects would decrease by about 10 percent. The predicted costs associated with reactor accidents at Indian Point are shown in Figures III.C.10 and III.C.21. The major contribution to the cost from the largest accidents is from interdicting those areas where reasonable decontamination procedures could not reduce the contamination to acceptable levels. Costs associated with decontamination and relocation expenses would also be significant. The other costs, associated with agricultural losses and evacuation, would not be significant in comparison to the total costs.

Land Contamination

One of the most important contributions to the property damage costs is from the land area that would require interdiction. A very small land area (less than one square mile) would probably need to be interdicted for the projected accidents. Figures III.C.11 and III.C.22 give the complementary cumulative distribution functions for the land contamination risks. As with the property damage estimated, the size of the land areas requiring protective measures will be correlated to the criteria which is used to assess the damage.

The health effects associated with liquid pathways from direct deposition and from groundwater sources have also been assessed in Section III of this testimony. It was concluded in Dr. Codell's testimony that there would not be significant health effects from liquid pathways in comparison to the above health effects.

Q.14 Does this conclude your testimony?

A.14 Yes.

PROFESSIONAL QUALIFICATIONS
ROGER M. BLOND
U.S. Nuclear Regulatory Commission

I am Roger M. Blond, Section Leader of the Accident Risk Section, Reactor Risk Branch, Division of Risk Analysis, Office of Research. I have been with the NRC since August 1974. In my present position, I am responsible for providing technical and managerial direction in developing methods and research in accident risk analysis and in performing applications in probabilistic risk assessment. This work includes: (1) developing risk models for calculating the physical processes and consequences of reactor accidents; (2) rebaselining accident consequences and reactor risk; and (3) developing value/impact analysis methods for reactor design improvements.

In addition to the Section Leader position, I have the following responsibilities:

- I am the Chairman of the International Benchmark Exercise on Consequence Modeling, sponsored by the Committee on the Safety of Nuclear Installations, of the Nuclear Energy Agency, Organization of Economic Cooperation and Development. As Chairman, I am responsible for organizing and directing the comparison study which includes the participation of 30 organizations representing 16 countries. The study was chartered to compare the large number of computer models that had been developed to calculate the offsite consequences of potential accidents at nuclear power facilities.

- I am responsible for developing the technical rationale for the development of improved siting criteria. This work includes the development of a set of representative potential reactor accident source terms, and a full parametric study of all the factors important to siting considerations from the risk perspective:

- I am a member of the Technical Writing Group of the IEEE/ANS PRA Procedures Guide - NUREG/CR-2300. This effort is developing a source document on PRA techniques. I am a co-author of the consequence modeling sections of the report.

- I am a member of the Department of Energy Working Group on Probabilistic Risk Assessment.

- I am a member of the NRC Incidence Response Center's Emergency Response Team.

In addition, I am directly involved in the development of a technical rationale for the NRC's Safety Goal, emergency planning and response, and numerous issues and questions which continuously arise in risk assessment.

I am also a lecturer on consequence modeling and accident analysis for the NRC Training Course on Probabilistic Safety and Reliability Analysis Techniques, for the IAEA Training Course on Nuclear Power, and for the George Washington University Seminar on Probabilistic Risk Assessment.

Risk Analyst

Before being selected for the Section Leader position, I was Senior Risk Analyst in the Office of Research. I was responsible for the following areas:

1. Consequence modeling research and development;
2. Performing and reviewing probabilistic risk assessments;
3. Siting and emergency planning and response criteria development; and
4. Integrating probabilistic risk assessment techniques into the regulatory and licensing process.

1. Consequence Modeling Research and Development

I was responsible for revising the consequence model that was developed for the Draft Reactor Safety Study. During the course of that effort, I developed the following modeling approaches and techniques which were used for the final Reactor Safety Study consequence model (CRAC) and are documented in Appendix VI of WASH-1400 and the CRAC User's Guide:

1. Meteorological sampling technique;
2. Diffusion modeling technique;
3. Time-varying meteorological model;
4. Depletion approach;
5. Finite cloud correction model for gamma shine;
6. Economic model;
7. Statistical sampling technique;
8. Emergency response model;
9. Property damage model; and
10. Population treatment.

After the completion of the Reactor Safety Study, I developed the following modeling techniques which have been incorporated into the CRAC-2 computer code and documented in the CRAC-2 User's Guide:

1. Revised comprehensive emergency response model;
2. Importance sampling for meteorological data and terrain diffusion model;
3. Revised dosimetry and health effects review; and
4. Comprehensive results display package.

I also performed numerous sensitivity and parametric studies on the models and input used in the consequence model and was responsible for an extensive research program to investigate the significance of various related phenomena to risk. This research involved from five to ten contractor personnel. I also have been responsible for preparing and defending the research program and budget in consequence modeling and emergency planning before the Senior Contract Review Board and the Advisory Committee for Reactor Safeguards.

2. Performing and Reviewing Probabilistic Risk Assessments

I was responsible for all of the risk calculations performed for the final Reactor Safety Study. At the completion of the study, I responded to critiques and questions concerning Probabilistic Risk Assessment from within the NRC, Congress, other Federal agencies, contractors and vendors, intervenors, state and local governments, utilities, and foreign governments. I have also performed risk studies or comparisons for the following analyses:

1. Task Force Report on Interim Operation of Indian Point;
2. Indian Point and Zion Site Risk and Alternative Containment Concepts Study;
3. Hatch consequence study;
4. Three Mile Island Potential Accident Consequence Study and Source Term Study;
5. Generic Environmental Statement on Mixed Oxide consequence study;
6. Anticipated transients without SCRAM consequence study;
7. Diablo Canyon Risk Assessment review; and
8. Clinch River Breeder Reactor consequence analysis review.

I have been responsible for advising and reviewing the following foreign risk assessments:

1. Norwegian Energy Study
2. Swedish Reactor Safety Study
3. German Reactor Safety Study
4. British Windscale and PWR Inquiries

In addition, the Norwegian Government personally invited me to Norway to review the approach and assumptions used in their study.

3. <u>Siting and Emergency Planning and Response Criteria Development</u>

I was the research consultant and member of the NRC/EPA Task Force on Emergency Planning. For the work of the Task Force, I was responsible for formulating the rationale for the emergency planning basis criteria and was the principal author of the Task Force Report on Emergency Planning (NUREG-0396). I also was responsible for developing the Emergency Action Level Guidance (NUREG-0654, Appendix 1) which establishes consistent criteria for declaring emergencies based upon plant parameters.

I performed a study on the cost/benefit of issuing Potassium-Iodide to the general public. Based on this report (NUREG/CR-1433), Potassium-Iodide is not being stockpiled for public distribution. In addition, I have performed numerous studies on emergency protective measures such as sheltering versus evacuation. I also developed the Three Mile Island Emergency Contingency Plan at the time of the accident.

I developed a ranking of high population sites which has been used to designate potentially high risk contributors.

4. <u>Integrating Probabilistic Risk Assessment Into the Regulatory Process</u>

I have provided technical direction on consequence modeling to the regulatory and licensing process for the following areas: Perryman Alternative Site Review; Environmental Impact Statement for Class 9 Accidents; Liquid Pathway Generic Study; in understanding the course and importance of potential accidents; and in source term development. I have on numerous occasions presented the results of my work on consequence modeling and emergency planning and response to other Offices within the agency, other organizations, the Advisory Committee on Reactor Safeguards, and the NRC Commissioners.

Science Applications, Inc. (SAI), April 1973 to April 1975, McLean, Virginia

I was involved with the design and implementation of two major projects.

The first project was the Atomic Energy Commission's Reactor Safety Study. I was a research analyst involved in developing and applying reliability methods in reactor accident sequence quantification and error/uncertainty propagation. I also was given responsibility for the development of an improved consequence model for the final version of the study.

The second project was the Federal Trade Commission's Market Basket Survey. This survey was designed to statistically determine a "typical" market basket of food for the average family and have an accurate comparison of grocery store pricing. I was retained as an expert consultant to the F.T.C. and helped design and implement the survey and analysis techniques.

Computer Sciences Corporation - August 1970 to April 1973, Arlington, Virginia

I was a task leader with Computer Sciences Corporation where I worked on the general support contract for the National Military Command System Support Center (NMCSSC) in the modeling and gaming department. I designed, implemented, and documented the Data Base Preparation Subsystem of the QUICK Reacting General War Gaming model. I was task leader for the QUICK production support task with responsibilities for maintenance and production support of the model and the associated damage assessment models. I was chosen as War Gaming Analysis Section representative to study and evaluate the consolidation and conversion of the Antiballistic Missile System (ABM-I) and QUICK Strategic War Gaming Models.

Imcor-Glenn Engineering, Inc. - June 1968 to April 1970, Rockville, Maryland

Imcor-Glenn Engineering, Inc. Operations Supervisor, Programmer - I was contracted to work for the Naval Ships Research and Development Center on testing and evaluation of the Small Boats Project (PCF) and on the Sonar Dome Project. I was also contracted to the Naval Research Laboratory as site team leader for testing and evaluation of Ultra High Frequency Radio Wave Study. As operations supervisor for the Data Division of Imcor, I was responsible for programming and quality control of processed data.

Awards, Honors, and Publications

I received the NRC Special Achievement Award on October 29, 1976 and a NRC High Quality Award on May 11, 1978. I was a session chairman in Consequence Modeling for the American Nuclear Society/European Nuclear Society Topical Meeting on Probabilistic Risk Assessment, September 20-24, 1981 in Port Chester, New York. I was also a session chairman for the American Nuclear

Society Review Conference on the PRA Procedures Guide, April 1982, in Arlington, Virginia. For this conference, I organized three formal debates on current issues in consequence modeling. I have published numerous papers and reports in probabilistic risk assessment, consequence modeling, siting, emergency planning and response, and on the source term. A list of all publications is attached.

Education

I was awarded a Batchelors of Science in Computer Science in 1970 and a Masters of Science in Operations Research in 1973 from the American University in Washington, DC.

AUTHORED OR CO-AUTHORED THE FOLLOWING PUBLICATIONS

"Relationship of Source Term Issue to Emergency Planning," EPRI/NSA Workshop on Technical Factor Relating Impacts from Reactor Releases to Emergency Planning, Bethesda, MD, January 12-13, 1982.

Reactor Safety Study, WASH-1400, Appendix II and VI.

Nuclear Energy Center Site Survey Study, NUREG-001, Exhibit A, Section 6, part IV, "NEC Accident Risk Analysis."

Reactor Accident Source Terms: Design and Siting Perspectives, NUREG-0773, draft.

Regulatory Impact of Nuclear Reactor Accident Source Term Assumptions, NUREG-0771, April 1981.

Task Force Report on Interim Operation of Indian Point, NUREG-0715, August 1980.

Planning Basis for the Development of State and Local Government Radiological Response Plans in Support of Light Water Nuclear Power Plants, NUREG-0396, December 1978.

Emergency Action Level Guidelines for Nuclear Power Plants, NUREG-0610 (Appendix 1 of NUREG-0654, November 1980).

"Consequence Analysis Results Regarding Siting," 1981, Water Reactor Safety Meeting, Gaithersburg, MD.

"Calculations of Reactor Accident Consequences: User's Guide," draft.

A Model of Public Evacuation for Atmospheric Radiological Releases, SAND78-0092, Sandia Laboratories, Albuquerque, NM, June 1978.

Examination of the Use of Potassium Iodide (KI) as an Emergency Protective Measure for Nuclear Reactor Accidents, NUREG/CR-1433, SAND80-0981, Sandia National Laboratories, Albuquerque, NM, March 1980.

"Radiation Protection: An Analysis of Thyroid Blocking," IAEA International Conference on Current Nuclear Power Plant Safety Issues, Stockholm, Sweden, October 20-24, 1980.

"International Standard Problem for Consequence Modeling: Results," International ANS/ENS Topical Meeting on Probabilistic Risk Assessment, Port Chester, NY, September 1981.

"Recent Developments in Consequence Modeling," presented at the Jahreskolloquium PNS, Kernforschungszentrum Karlsruhe, Federal Republic of Germany, November 1981.

"International Standard Problem for Consequence Modeling," International ANS/ENS Topical Meeting on Probabilistic Risk Assessment, Port Chester, NY, September 20-24, 1981.

"Environmental Transport and Consequence Analysis," International ANS/ENS Topical Meeting on Probabilistic Risk Assessment, Port Chester, NY, September 20-24, 1981..

"Weather Sequence Sampling for Risk Calculations," Transactions of the American Nuclear Society, 38, 113, June 1981.

Calculations of Reactor Accident Consequences, Version 2: User's Guide, NUREG/CR-2326, SAND81-1994, Sandia National Laboratories, Albuquerque, NM, (to be published).

"Investigation of the Adequacy of the Meteorological Transport Model Developed for the Reactor Safety Study," ANS Topical Meeting on Probabilistic Analysis of Nuclear Reactor Safety, Newport Beach, CA, May 8-10, 1978.

USNRC, "Environmental Transport and Consequence Analysis," Chapter 9 and Appendices D, E, and F in PRA Procedures Guide, Review Draft, NUREG/CR-2300, 1981.

Overview of the Reactor Safety Study Consequence Model, U. S. Nuclear Regulatory Commission, NUREG-0340, 1977.

PROFESSIONAL QUALIFICATIONS
FRANK H. ROWSOME, 3rd
U.S. NUCLEAR REGULATORY COMMISSION

I am Frank H. Rowsome, 3rd, Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research. I have served in that capacity since joining the NRC in July 1979. The work entails planning, budgeting, managing and staffing the Division. Much of the work of the Division is devoted to research in reactor accident risk assessment. The remainder entails risk assessment applied to non-reactor aspects of the nuclear fuel cycle and to standards development related to system reliability or risk.

I received a bachelor's degree in physics from Harvard in 1962. I studied theoretical physics at Cornell, completing all requirements for a Ph.D except for the dissertation in 1965. From 1965 to 1973, I taught and engaged in research in theoretical physics at several colleges and universities.

In 1973 I joined the Bechtel Power Corporation as a nuclear engineer. My initial assignment was to perform accident analyses for nuclear plant license applications. After six months in that job, I was transferred to a newly formed group of systems engineers charged with developing for Bechtel a capability to perform risk assessments and system reliability analyses of the kind the NRC was then developing for the Reactor Safety Study. In that capacity I performed reliability analyses of nuclear plant safety systems, developed computer programs for system reliability analyses, performed analyses of component reliability data, human reliability analyses, and event tree analyses of accident sequences. I progressed from nuclear engineer, to senior engineer, to group leader, to Reliability Group Supervisor before leaving Bechtel to join the NRC in 1979. In this last position at Bechtel, I supervised the application of engineering economics, reliability

engineering, and analysis techniques to power plant availability optimization as well as nuclear safety analysis.

While serving as Deputy Director of the Division of Risk Analysis (and its anticedent, the Probabilistic Analysis Staff), I also served as Acting Director (7 months), acting chief of the Reactor Risk Branch (9 months) and acting chief of the Risk Methodology and Data Branch (4 months).

This experience has given me the practitioner's view as well as the manager's view of those facits of reactor risk assessment entailing the classification of reactor accident sequences, system reliability analysis, human reliability analysis, and the estimation of the likelihood of severe reactor accidents. I have the manager's perspective but not the practitioner's experience with those facits entailing containment challenge analysis, consequence analysis, and risk assessment applied to other parts of the nuclear fuel cycle.

My role in the development of testimony for this hearing has been as coordinator of the preparation of testimony on risk and one of the coordinators of the technical critique of the licensee's "Indian Point Probabilistic Safety Study." I am not an expert on the design or operation of the Indian Point plants.

List of Publications

1. "The Role of System Reliability Prediction in Power Plant Design," F.H. Rowsome, III, Power Engineering, February 1977.

2. "How Finely Should Faults be Resolved in Fault Tree Analysis?" by F.H. Rowsome, III, presented at the American Nuclear Society/Canadian Nuclear Association Joint Meeting in Toronto, Canada, June 18, 1976.

3. "The Role of IREP in NRC Programs" F.H. Rowsome, III, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

4. "Fault Tree Analysis of an Auxiliary Feedwater System," F.H. Rowsome, III, Bechtel Power Corp., Gaithersburg Power Division, F 77 805-5.

MS. MOORE: Now, gentlemen, I think we could, unless the parties insist on it, we could forego the summary statements. Are you prepared to go right into cross-examination?

MR. BLUM: We would consent.

JUDGE GLEASON: We waive that.

MS. MOORE: We have several pieces of testimony that we wanted to put in. That's what I wanted to do next.

JUDGE GLEASON: All right, go ahead.

BY MS. MOORE: (Resuming)

Q Gentlemen, do you now have before you a copy of a document entitled "Direct Testimony of Frank Rowsome and Roger Blond Concerning Commission Question One"?

A (WITNESS ROWSOME) Yes.

A (WITNESS BLOND) Yes.

Q Was this testimony prepared by you or did you participate in its preparation?

A (WITNESS ROWSOME) Yes.

Q Do you have any additions or corrections?

A (WITNESS ROWSOME) Yes, a few.

Page 7, answer 13, the last line. The word "assured" should be "assumed".

On page 9, answer 16, firset line. Where it says "Table III.C.5", that should be followed with a period rather than a comma, and the "i" on the following word "it" should be capitalized to begin a new sentence.

JUDGE GLEASON: Excuse me, Mr. Rowsome. Would you start again?

WITNESS ROWSOME: Page 9, answer 16, line 1. There now is a common after "III.C.5". Make that a period and capitalize the next letter.

Page 10, bottom line of the table where it says "Site total", first column now reads "1.9B"; should be "1.96". And in the footnote to that same table, the first line of the footnote in quotes is "early reloc/later reloc". It should be "late reloc". Delete the "r" in "later".

Page 11, bottom line of the fat paragraph in the middle of the page -- I notice next to the bottom line "evacuation" is misspelled. The "c" and the "u" are inverted.

On the last line, the second word now reads "preclude"; should read "precede".

On page 12, top line, last word is "as". It should be "vs." as in "versus".

MR. BRANDENBURG: Would you repeat that one, please?

WITNESS ROWSOME: Page 12, top line, last word. Replace "as" with "vs."

Same page, answer 18, line 1. Middle of that line: "very low risk. Because".

Page 13, last paragraph of answer 20, fourth line, about the middle of that line, "moving people from". Caret in the word "the", so it reads "moving people from the comparatively small area.

Page 14, top paragraph, fifth line from the bottom, which reads "after the accident in the late relocation model", should read "after the accident. In the late relocation model".

That completes my corrections to this piece of testimony.

Q With these changes to your testimony, is it true and correct to the best of your knowledge, information, and belief?

A (WITNESS ROWSOME) Yes, it is.

A (WITNESS BLOND) Yes.

Q Do you adopt this as your testimony in this proceeding?

A (WITNESS ROWSOME) Yes, I do.

A (WITNESS BLOND) Yes.

MS. MOORE: Copies of this testimony have been provided to the Board, the parties, and the Court Reporter. I ask that the testimony be admitted into evidence and bound into the record as if read.

JUDGE GLEASON: Is there objection?

(No response.)

JUDGE GLEASON: Hearing none, the testimony will be received into evidence and bound into the record as if read.

(The prepared testimony of Mr. Rowsome and Mr. Blond follows.)

(IV.B)

#5

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CONSOLIDATED EDISON OF NEW YORK (Indian Point, Unit 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit 3)	)))))))	Docket Nos. 50-247-SP 50-286-SP

DIRECT TESTIMONY OF FRANK ROWSOME AND ROGER BLOND
CONCERNING COMMISSION QUESTION 1

Q.1 State your name and position with the NRC.

A.1 My name is Frank H.Rowsome. I am Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research.

Q.2 What are your responsibilities in that position?

A.2 I assist the Director in planning and managing the research program in risk assessment, probabilistic safety analysis, operations research, reliability engineering, and related regulatory standards development.

Q.3 Have you prepared a statement of your professional qualifications?

A.3 Yes, the statement of my professional qualifications is attached to this testimony.

Q.4 State your name and position with the NRC.

A.4 My name is Roger M. Blond. I am the Section Leader for the Accident Risk Section of the Reactor Risk Branch of the Division of Risk Analysis of the Office of Research.

Q.5 What are your responsibilities in that position?

A.5 I am responsible for providing technical and managerial direction in developing methods and research in accident risk analysis and in performing applications in risk assessment.

Q.6 What is the purpose of this testimony?

A.6 Commission Question 1 calls for an assessment of the risk pending and after any improvements in emergency preparedness identified in the response to Commission Question 4. The bulk of the risk testimony by the staff describes the risk pending these improvements. The purpose of this testimony subsection is to identify the risk reduction potential of improvements in emergency preparedness.

Q.7 Please summarize your findings.

A.7 The risk reduction attributable to improvements in emergency preparedness is not known, but is not expected to be large.

Q.8 What improvements in emergency preparedness are considered?

A.8 The staff has not attempted to model specific improvements in emergency preparedness. Rather, we will display and discuss sensitivity studies to show the influence of various emergency response strategies on risk.

Q.9 Why has the staff not attempted to calculate the risk reduction afforded by specific improvements in emergency preparedness?

A.9 We can and have calculated the effects of emergency response upon risk. However, we do not have an objective and useful way to translate the state of emergency planning and preparedness into a model of emergency response effectiveness. In developing PRA models we prefer to use objective, historical data for the reliability of safety functions. Thus, we are led to look at the difference between historical examples of planned vs. unplanned evacuations to model the effect of emergency preparedness upon emergency response. The historical data suggest that there is no statistically significant difference between planned and unplanned evacuations. See, e.g., J. M. Hans, Jr., and T. C. Sell, "Evacuation Risks - An Evaluation," U.S. Environmental Protection Agency, EPA-520/6-74-002 (1974). Were we to employ this data, it would show no effect of emergency preparedness upon emergency response, and therefore no effect upon risk. This is not to say that there is really no effect, only that we cannot objectively predict it with available data. However, we can have some confidence that evacuations with or without planning will generally take place expeditiously.

Q.10 What emergency response scenarios have been employed in the risk calculations for Indian Point?

A.10 The emergency response scenarios are defined in Sarbeswar Acharya's testimony in Section III.C.A above. Three emergency response scenarios, each with and without supportive medical treatment, have been analyzed, giving six distinct cases. They are defined in Table III.C.2. Briefly, the three emergency response scenarios are these:

1) Evacuation-relocation model

The model is taken to be representative of emergency response if no external event, such as an earthquake or hurricane, compromises evacuation or shelter feasibility, and the response of choice is evacuation. Evacuation of the 10 mile radius EPZ begins two hours after warning and the effective radial evacuation speed is taken to be an average of 1 1/2 miles per hour. Shielding factors typical of everyday life are applied before evacuation and beyond 10 miles. Beyond 10 miles people remaining in areas of severe fallout contamination (projected seven-day dose greater then 200 rem) are assumed to be relocated 12 hours after plume passage. People in areas of less severe but still significant fallout contamination are assumed to be relocated 7 days after plume passage.

2) Early relocation model

The early relocation model of emergency response portrays a case in which the public takes no evasive action prior to plume passage. Shielding factors typical of everyday life are employed in the dose calculation. Eight hours after plume passage, people in the footprint of the plume within the plume exposure EPZ are assumed to be relocated to uncontaminated ground, so that they cease to accumulate a dose from fallout eight hours after plume passage. Beyond 10 miles, people in areas of severe fallout contamination (projected seven day dose greater than 200 rem) are assumed to be relocated 12 hours after plume paggage, just as in the "evac-reloc" model. Likewise, people beyond the EPZ in areas of less severe but still significant fallout contamination are assumed to be relocated 7 days after plume passage.

3) Late relocation model

This model is taken to be representative of the case in which a severe earthquake or hurricane precludes evacuation, damages buildings so that no sheltering shielding factors are applied - as though everyone were outdoors - and relocation from areas of severe fallout contamination is delayed for 24 hours after plume passage.

Q.11 How do the projected risks differ for these three emergency response scenarios?

A.11 The comparison for Unit 2, as it is currently designed and operated is shown in Table IV.B.1 below. This table summarizes results from Dr. Acharya's tables III.C.6, 13 and 20.

TABLE IV.B.1
Expected Risks for Indian Point Unit 2
vs. Emergency Response Model

Risk type	evac-reloc[1]	early reloc[1][3]	late reloc
Early fatalities w[2]	0.0148	0.0149	0.0252
Early fatalities wo[2]	0.0360	0.0361	0.0634
Early injuries	0.115	0.115	0.166
Total cancer fatalities	0.209	0.210	0.228
Person rem	2610.	2610.	2810.
Property damage ($)	281,000	263,000	262,000
Source table	III.C.6	III.C.13	III.C.20

(1) late relocation is applied to accidents caused by earthquakes and hurricanes in each case.
(2) w = with supportive medical treatment, wo = without.
(3) Release Category C is modeled with evacuation for those occurrences not caused by earthquakes or hurricanes.

The corresponding results for Unit 3 are shown in Table IV.B.2, which summarizes Dr. Achary's tables III.C.7,14,and 20.

TABLE IV.B.2
Expected Risks for Indian Point Unit 3
vs. Emergency Response Model

Risk type	Expected (average) casualities per unit year		
	evac-reloc[1]	early reloc[1][3]	late reloc
Early fatalities w[2]	.00375	.00390	.0125
Early fatalities wo[2]	.0111	.0113	.0353
Early injuries	.0409	.0412	.0762
Total cancer fatalities	.1138	.1144	.1292
Person rem	1430	1440	1600
Property damage ($)	165,000	145,000	144,000
Source table	III.C.7	III.C.14	III.C.20

(1) Late relocation is applied to accidents caused by earthquakes and hurricanes in each case.
(2) w= with supportive medical treatment, wo= without.
(3) Release category C is modeled with evacuation for those occurences not caused by earthquakes or hurricanes.

Q.12 What inferences do you draw from Tables IV.B.1 and 2?

A.12 First note that the annual average health risks are quite small (well below one casualty per unit year) in all the risk categories. Next, note that "early relocation" is very nearly as effective as "evacuation/relocation" in limiting expected health risks. The two cases differ by 4% or less in each risk category in Tables IV.B.1 and 2, though not all accidents are modeled as having a different emergency response in the two cases. Third, note that either early relocation or evacuation yields lower expected risks than late relocation. Fourth, note that supportive medical treatment, if available to those receiving high doses, can substantially reduce early fatalities.

Q.13 Why is the property damage estimate higher with evacuation than without?

A.13 The property damage estimate includes the cost of evacuation as well as the costs associated with interdiction, cleanup, etc. The latter costs are the same in each case. The difference arises from the costs of the evacuation when it is assured to take place.

Q.14 Is it suprising that the latent cancer fatality and person rem risks for the evacuation/relocation model is very close to the value for the early relocation model?

A.14 No. Person-rem, and the latent casualty risks that are thought to be very roughly proportioned to person-rem, are only modestly influenced by what happens in the plume exposure EPZ. These are long-range effects. The two emergency response models evac/reloc and early reloc are identical in their portrayal of emergency response beyond ten miles.

In Dr. Acharya's Table III.C.12, where the contributions to the societal latent cancer fatality risk are displayed as a function of distance from the reactor to the site of exposure, one sees that most of the latent cancer committments originate from exposures at distances greater than 10 miles.

Q.15 Why is evacuation/relocation only slightly more effective than early relocation in limiting the average values of early fatalities?

A.15 An important clue to the cause of this surprising result can be found in Tables III.C.6,7,13 and 14. Most of the early casualities originate in accidents triggered by earthquakes or hurricanes.

We have assumed that any earthquakes or hurricanes severe enough to trigger an accident at either unit would also render the roads impassable and threaten to deprive the population of the benefits of shielding factors typical of everyday life (most people in-doors). We have not done a non-nuclear risk assessment to evaluate the direct effects of such earthquakes or hurricanes. Instead, our model is conservative. For reactor accidents triggered by earthquakes and hurricanes everyone is modeled as being outdoors, no anticipatory evacuation takes place, and relocation from ground severly contaminated by fallout does not occur until 24 hours after plume passage.

One can trace the origin of the expected risks to release categories (using tables III.C.4 and 5). These can further be traced to damage states using Dr. Meyer's containment event trees in section III.B of the testimony. The testimony in III.A can then be used to trace contributors to their origins in accident sequences. When this is done for early fatalities, the following picture emerges.

Table IV.B.3 makes it clear that 90% of the expected early fatality risk posed by severe reactor accidents at the site can be traced to earthquakes and hurricanes. Since we have assumed at the outset that evacuation (as opposed to late relocation) cannot be applied to these accidents, it is clear that anticipatory evacuation is only being considered as potentially applicable for 10% of the early fatality risk.

Q.16 Can other clues to relative effectiveness of anticipatory evacuation vs early relocation be found in the risk analysis?

A.16 Yes. See, for example, table III.C.5, it describes the average consequences to be expected for each release category for each emergency response model at each plant.

TABLE IV.B.3
Origins of early fatality expected risks posed by accidents at Indian Point Units 2 and 3*

Accident sequence	expected risk early fatalities per year	percent of early fatality percent of site total early fatality projections
Seismic: Direct Containment (Backfill) Failure at Unit 2	6×10^{-3}	31%
Seismic: Loss of control or power at Unit 2	4.9×10^{-3}	25%
Hurricane: Loss of all AC power due to high winds (Unit 2)	3.6×10^{-3}	18%
Seismic: Loss of control or power at Unit 3	2.8×10^{-3}	14%
Interfacing system LOCA, Unit 3 RHR suction line	7.3×10^{-4}	3.7%
Interfacing system LOCA, Unit 2 RHR suction line	6.7×10^{-4}	3.4%
Seismic: Direct Containment (backfill) failure at Unit 3	3.3×10^{-4}	1.7%
Fire: resulting in loss of all cooling, Unit 2	2.7×10^{-4}	1.4%
Fire: resulting in loss of all cooling, Unit 3	2.2×10^{-4}	1.1%
All other sequences combined		0.7%
Site total	$1.9b \times 10^{-2}$	100%

*Evaluated for the "after fix" design and "early reloc"/later reloc" emergency response. For no case is evacuation credited. Supportive medical treatment is assumed.

Anticipatory evacuation (if feasible) is an effective early fatality risk reduction strategy for Release Category C,D,E,F and G. By that I mean that large percentage reductions in average early fatalities can be had by replacing the early relocation model with the evacuation/relocation model. However, note that the expected number of early fatalities are not very large for any of these release categories.

Average early fatalities in the thousands are expected only for Release Category A or B events. The percentage change in early fatalities associated with the replacement of early relocation with evacuation is small for these release categories. Thus table III.C.5 seems to suggest that evacuation tends not to be an effective strategy for the high-consequence release categories, but is effective for the lower-consequence release categories. One of the principal reasons for this can be found in the characteristic times of the accidents. The high consequence release category A and B events proceed very quickly. The warning time for these accidents is modeled to be one hour, whereas the delay time between notification and the start of evacuation is modeled to be two hours. Thus the plume will emerge from the plant one hour ahead of the start of evacuation, as we have modeled it. This may or may not be realistic, but it is clear that we cannot count on evaucation to reliably preclude plume arrival for these quickly developing releases.

In addition, under rare weather conditions, the release category A and B events can yield early fatalities beyond 10 miles. Our model does not credit evacuation beyond ten miles. This, too, helps to account for the similarity in early fatality projections for evacuation as early relocation in release category A or B accidents.

Q.17 Would anticipatory evacuation appear to offer much greater risk reductions if it were modeled to take less time to evacuate the plume exposure EPZ?

A.17 No, not unless anticipatory evacuation were assumed to be feasible for earthquake and hurricane-induced accidents as well as accidents of on-site origin, and be rapid for both classes of accidents.

Q.18 Could a change in the accident likelihood portion of the PRA for Indian Point show anticipatory evacuation to be substantially more effective in limiting early fatalities?

A.18 No, except for cases of very low risk, because there are no release categories for which the early fatality consequence is large and anticipatory evacuation is highly effective, there can be no mix of these release categories, weighted by likelihood, that would show evacuation to have substantial leverage on a high risk of early fatalities.

Q.19 What are the key assumptions to which the finding is sensitive that early relocation is nearly as effective as anticipatory evacuation?

A.19 The heart of the finding lies in the consequence analysis. However, since there are diverse and redundant reasons for believing that the risk with an anticipatory evacuation emergency response is not, on the average, appreciably lower than the risk with early relocation, we infer that the finding is one of the more reliable insights into risk to be drawn from the PRA.

Q.20 What are the key differences between anticipatory evacuation and relocation?

A.20 As modeled in the PRA, evacuation starts after the warning is given, and results in an initial delay period followed by people moving radially outward from the plume exposure EPZ, without regard to actual plume direction. Relocation, on the other hand, is modeled as the end time after which people cease to accumulate ground exposure due to fallout contamination.

In practice, we interpret evacuation as an anticipatory action to avoid plume and/or ground exposure. Relocation, on the other hand, is based upon measured levels of ground contamination and can be much more discriminating.

Evacuation does not require mapping of ground contamination, but it does entail moving large populations substantial distances. Relocation presumes that ground contamination has been mapped, but it need entail no more than moving people from comparatively small area of highly contaminated ground short distances to the nearest area where the contamination is low. Thus the resource requirements and practical problems in the way of effective relocation are quite different from those of evacuation.

Q.21 What is the difference between the "early reloc" and "late reloc" models?

A.21 The two relocation models differ in relocation time, in relocation criterion, and in shielding factors applied.

In the early relocation model, everyone within the plume exposure EPZ ceases to accumulate doses from ground contamination eight hours after plume passage, without regard to levels of ground contamination. Beyond ten miles, people in highly contaminated areas (projected seven-day dose to the bone marrow over 200 rem) are relocated 12 hours after plume passage. People beyond ten miles in areas of lesser fallout contamination cease to accumulate early exposure doses from fallout seven days after the accident in the late relocation model, at all distances from the site, people in highly contaminated areas are relocated 24 hours after plume passage, and people in areas of lesser contamination are taken out of the early exposure calculation at 7 days of ground exposure.

The early relocation model entails sheltering shielding factors typical of everyday life, whereas in the late relocation model, everyone is presumed to be out-doors.

Q.22 What interpretation can be given to the differences in risk between the "early reloc/late reloc" risk estimates and the pure "late reloc" risk estimates?

A.22 The differences in expected risks are summarized in Table IV.B.1 and 2, drawn from Dr. Acharya's Tables III.C.13, 14, and 20. In both cases the accidents attributed to earthquakes and hurricanes, the regional non-nuclear disasters, are modeled with late relocation. Therefore the difference originates in the treatment of accidents not triggered by earthquakes and hurricanes.

Early fatalities and early injuries are appreciably lower with early relocation rather than late relocation. There is a slight difference in cancer fatalities and person rem in the two models. It is not surprising that there is little difference for person rem. Much of the expected person rem originates in the large number of people who receive small individual doses of radiation at considerable distances.

Clues to the origin of the more substantial influence on early health effects can be seen in Dr. Acharya's Tables III.C.17 and 18. Those accidents originating in earthquakes and hurricanes cause early fatalities at greater distances than do accidents of on-site origin. Part of this difference originates in the difference in the mix of release categories for these two groups of accidents, but part is also due to the difference in emergency response assumed. This can be seen in Table III.C.5. A level of exposure too small to cause early fatalities with the better shielding and quicker relocation associated with "early reloc" may rise to a level of exposure above the threshold for early fatalities with the lesser shielding and more prolonged exposure of the late relocation model. Therefore one would expect a greater range and larger area within which people might incur early health effects if the late relocation model is applicable than would be the case if early relocation or evacuation applies.

Q.23 What inferences do you draw from the foregoing analysis on the effectiveness of emergency response strategies at risk reduction?

A.23 Several inferences seem to follow:

1) The provision of supportive medical treatment can lower early fatality risks. See, eg., Tables III.C.6,7 etc., and compare, eg., Figure III.C.1 and 2.

2) The time within which people are relocated from areas highly contaminated by fallout can influence the dose committment. Early relocation can shrink the area within which people could incur doses approaching the threshold for early injuries or early fatalities.

3) Sheltering can influence the dose committment. This sheltering can also shrink the area within which people could incur doses approaching the threshold for early injuries or fatalities.

4) Anticipatory evacuation-as a general strategy-appears to offer very little risk reduction at Indian Point compared with early relocation. There are two principal reasons for this:

   a) Earthquakes and-to a lesser extent-hurricanes play a large role in the risk profile of the Indian Point Units. The feasibility of evacuation is in doubt for these events. We have pessimistically assumed that neither anticipatory evacuation nor early relocation is feasible for such accident scenarios.

   b) We do not feel justified in assuming that evacuation can reliably clear the ten mile EPZ ahead of plume arrival for the more rapidly evolving accidents. The more slowly evolving accidents-for which evacuation is highly effective-have less severe consequences with or without evacuation than do some of the rapidly evolving accidents.

Q.24 What inferences can be drawn on the effectiveness of emergency preparedness as a risk limitation strategy?

A.24 Since we have identified no objective means to map the state of emergency preparedness into a prediction of the speed or reliability of emergency response, we cannot draw any quantitative conclusion. However, evacuation planning, as distinct from other elements of emergency preparedness, does not appear to be a fruitful risk limitation tactic.

Q.25 Does this conclude your testimony on Commission Question 1?

A.25 Yes.

BY MS. MOORE: (Resuming)

Q Mr. Rowsome, do you have before you a document entitled Direct Testimony of Frank H. Rowsome concerning IV.C, Accuracy of the Risk Assessments?

A (WITNESS ROWSOME) Yes, I do.

Q Was this testimony prepared by you?

A (WITNESS ROWSOME) Yes, it was.

Q Do you have any additions or corrections?

A (WITNESS ROWSOME) Sorry to say, yes.

Page 3, top line, "comprehensive" is misspelled. Change the "a" to an "e," although I am not an expert on spelling.

Answer 7 on the same page --

JUDGE GLEASON: Could you hold just a minute, please?

JUDGE PARIS: Ms. Moore, could you read the title of the testimony again? We've got so much from Mr. Rowsome.

MS. MOORE: Direct Testimony of Frank H. Rowsome Concerning IV.C, Accuracy of the Risk Assessments

WITNESS ROWSOME: I apologize that our coding scheme of roman numerals and letters appears to have broken down in places.

JUDGE GLEASON: Go ahead, Mr. Rowsome.

WITNESS ROWSOME: Page 3, top line, a spelling error in "comprehensive."

Answer 7, same page, fourth line, now reads, "The first PRA's in which this has been done," should read, "The first published PRA's." Add the word "published" after "first."

Page 19, the over line should be continued into a square root sign over the polynomial, and in the middle term, that is, between the two equal signs, the 4.25 ought also to be under a square root sign. The little v-like symbol at the left to indicate that is a square root sign, that never got put in.

In addition, the factors of two following the parentheses in that first polynomial are exponents, and should have been superscripts.

That completes my corrections for this piece of testimony.

BY MS. MOORE: (Resuming)

Q With these changes to your testimony, is it true and corret to the best of your knowledge, information, and belief?

A (WITNESS ROWSOME) Yes.

Q Do you adopt this as your testimony in this proceeding?

A (WITNESS ROWSOME) Yes.

MS. MOORE: Copies of this testimony have been delivered to the Board, the parties, and the Court Reporter. I ask that the testimony be admitted into evidence and bound into the record as though read.

JUDGE GLEASON: Is there any objection?

(No response.)

JUDGE GLEASON: Hearing none, the testimony will be received into evidence and bound into the record as if read.

(The prepared testimony of Mr. Rowsome follows.)

#6

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket Nos. 50-247-SP
CONSOLIDATED EDISON	)	50-286-SP
OF NEW YORK (Indian Point, Unit 2)	)	
	)	
POWER AUTHORITY OF THE STATE	)	
OF NEW YORK (Indian Point, Unit 3)	)	

DIRECT TESTIMONY OF FRANK H. ROWSOME
CONCERNING IV.C ACCURACY OF THE RISK ASSESSMENTS

Q.1 State your name and position with the NRC.

A.1 My name is Frank H. Rowsome. I am Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research.

Q.2 What are your responsibilities in that position?

A.2 I assist the Director in planning and managing the research group in risk assessment, probabilistic safety analysis, operations research, reliability engineering, and related regulatory standards development.

Q.3 Have you prepared a statement of your professional qualifications?

A.3 Yes, the Statement of my professional qualifications is attached to this testimony.

IV.C Accuracy of the Licensee and Staff Risk.

Q.4 What is the purpose of this testimony?

A.4 The purpose of this testimony is to discuss the accuracy of the IPPSS and the Staff assessment of risk.

Q.5 Please summarize your conclusions.

A.5 The uncertainties in the predictions of risk posed by severe reactor accidents at Indian Point Units 2 and 3 are large. We have been unable to pinpoint the absolute risk.

Q.6 How has the staff treated uncertainties in its calculations of severe accident risk posed by Indian Point Units 2 and 3?

A.6 The Staff has not attempted to formally calculate the uncertainties in our own risk calculations for Indian Point principally because there are many sources of uncertainty, such as modeling approximations and completeness issues for which the uncertainty cannot be mathematically derived.

It is possible to perform sensitivity studies to gauge the effect of specific sources of uncertainty. The staff has done this in some cases that are documented in NUREG/CR-2934 or in Section III of this testimony. It is also possible to translate ones judgment about the magnitude of uncertainty contributors into a mathematical model that can be used to develop an analysis of the accuracy of the bottom line risk predictions. This has been done in the IPPSS. We see some merit in using engineering judgment to arrive at a comprehensive, albeit subjective, treatment of uncertainties in this way. On the other hand, the staff has not attempted a subjective assessment of this kind.

Our principal approach to the treatment of uncertainties has been to give a qualitative account of the sources of uncertainty throughout our testimony on risk.

Q.7 Please describe the treatment of uncertainties in the Indian Point Probabilistic Safety Study.

A.7 The licensees have mathematically propagated quantitative estimates of the uncertainties throughout their risk calculations. The Indian Point Probabilistic Safety Study and the Zion Probabilistic Safety Study are the first PRAs in which this has been done. Statistical uncertainties were inferred using engineering judgment from their failure rate data base. Some accounting is given of correlated failures of multiple components within each safety system and of completeness problems in modeling the reliability of each system. Both coupled and random sources of variance were incorporated in the models of seismic fragility. Engineering judgment was used to portray the uncertainties originating in the estimation of fission product releases and consequences. All these sources of uncertainty were combined using numerical integration to yield an estimate of the range of potential error in the bottom-line risk predictions.

Q.8 What is your opinion of the IPPSS estimates of uncertainty?

A.8 The treatment of uncertainty in the IPPSS is the most comprehensive, quantitative assessment of uncertainties that has been given in a PRA to date. Nonetheless, I believe that it is plausible that the actual risk might be outside the range of risks identified in the IPPSS.

Q.9 Why do you feel that the uncertainty range calculated in the IPPSS is too narrow?

A.9 Both Robert Budnitz and Ben Buchbinder have testified in IIIA above that the uncertainties in their review areas (earthquakes, other external events, and fires) may be broader than the rather broad uncertainty bands used to describe these analyses in IPPSS principally because the methodological limitations and sensitivities of these pioneering calculations are not well-understood. In addition, James Meyer has testified in IIIB above that some of the models of core melt phenomena used in IPPSS represent one among a variety of possible courses accidents might take, so there appears to be greater uncertainty in the likelihood and character of containment failure modes than IPPSS takes into account. The judgmental treatment of uncertainties in the quantities of radioactive materials released and the consequences of releases employed in the "U-factors" in the Level II analysis in the IPPSS is quite simplistic, though not necessarily in error.

There are some other shortcomings in the treatment of uncertainties in the IPPSS that originate in modeling approximations or completeness issues. Among these are the omission of a model of sabotage, possible modeling errors in the event trees, and common cause failures other than those originating in the external events or fires.

In short, it is quite plausible to us on the staff that the true risks posed by severe reactor accidents at Indian Point Units 2 and 3 might lie outside the range suggested by the uncertainty calculations in IPPSS, either toward higher or lower risks.

Q.10 Please give a technical summary of the sources of uncertainty in the staff calculations of severe accident risk.

A.10 There are many uncertainties in the risk assessment. The easiest way to address the uncertainties is to take each of the principal phases of the risk assessment in turn and ask about the uncertainties in each separately.

Q.11 How might the uncertainties in accident likelihood affect the projected risk?

A.11 There are four kinds of uncertainties or possible errors that affect accident likelihood assessments. These are (1) statistical uncertainties, originating in the fact that we cannot measure component failure probabilities or human error probabilities or other input parameters with precision, (2) modeling approximations introduced to make the predictive models tractible, (3) errors of completeness: some failure mechanisms or scenarios have been left out entirely, and (4) arithmetic errors in assembling the models.

Q.12 How might statistical uncertainties affect the estimates of risk?

A.12 Statistical uncertainties have been calculated in the IPPSS. The results can be found in Figures 8.2-1 and 8.2-4 of the Indian Point Probabilistic Safety Study (Volume 12, pp. 8.2-2 and -3). The width of the peaked curve in the graphs give the licensees' estimate of the range of uncertainty.

Errors in PRAs originating in statistical uncertainties are, in general, no more likely to lead to over-estimates than underestimates of risk.

Dr. Robert Easterling has estimated the confidence intervals associated with many Indian Point accident frequency estimates in NUREG/CR-2934. He employed the Maximus method, an adaptation of classical statistics quite different from the Bayesian statistical methods employed in the IPPSS. His results are not significantly different from those in the IPPSS, from which I infer that the choice of statistical method is not a large source of uncertainty or potential error in most of the accident sequence likelihood estimates. Dr. Easterling has identified some isolated cases, documented in NUREG/CR-2934, where the choice of the statistical model or the data is quite sensitive. There are particularly large uncertainties surrounding our estimate of the likelihood of the double valve failure responsible for the uncontained interfacing system LOCA accident sequence.

Q.13 What influence have modeling approximations on the accuracy of the projected severe accident risks?

A.13 Modeling approximations are almost always taken in the pessimistic direction. They tend to exaggerate the risk.

An example is the treatment of partial failures. Safety functions that do not work as expected but do work partially are treated as outright failures. The risk assessment treats severe core damage, such as occurred at Three Mile Island, as a full core meltdown. The influence of these modeling approximations on the bottom line risk predictions cannot be formally calculated. However, we have some experience with refining such approximations. Many practioners of risk assessment believe that the exaggeration of the risk predictions caused by modeling approximations is compensated by the errors of omission in the risk models, although there is no reason to believe that this is always or precisely true.

Q.14 What influence have errors of omission on the accuracy of the projected risk?

A.14 Errors of omission generally lead to underestimates of accident likelihood and thus underestimates of risk. We know that a number of contributory mechanisms to accidents have been left out of the risk models: sabotage, those design errors (other than in seismic fragility) that have not been revealed by documents or by in-service experience, pressurized vessel thermal shock, etc. In addition, some contributors have been given skimpy and unreliable treatment, e.g., operator misdiagnosis of accidents in progress and perhaps DC power supply failures. These may contain errors of omission. Some errors of omission, such as operator innovations to jury-rig fixes for failed equipment, lead to overestimates of risk.

The implications for the accuracy of the risk predictions are not so bleak as this list of omissions seems to suggest, however. There are two reasons why these errors of omission are unlikely to affect the predicted risk to public health and safety. First, there are a great many severe accident scenarios. Only a few of them control risk. The others are far too unlikely to make an appreciable difference. Most of the errors of omission, if corrected, would increase the likelihood of a few accident sequences from a level that is quite negligible to a level that is still very small in contribution to core melt likelihood or risk. This is not just happenstance. More care has been taken in modeling the more likely and more severe accidents, so that most of the errors of omission are in the very much less important contributors to risk.

The second reason that most errors of omission are unlikely to affect offsite radiological risk lies in the spectrum of consequences of different core melt sequences. Most of the offsite risk originates in accidents in which the core melts early and the containment is either bypassed, failed early, or has no working heat removal systems. There are only a few accident scenarios that can fail so many safety functions at the same time. There are many other ways that an accident could occur that leads to core damage or meltdown in an intact and cooled containment. We have found in Sections IIIC and IVA of this testimony that such accidents have comparatively minor offsite consequences, although they leave the utility with a very costly burden of replacement power, plant damage, and cleanup.

If there were an error of omission in the PRA that does significantly impact the likelihood of core melt, it would probably affect those kinds of accidents that are comparatively well-contained. It would increase the projected economic losses to the utility in the same porportion as the overall increase in core melt frequency. However, it would have very little effect on the projected offsite radiological losses unless it happened to involve an accident sequence in which both core melt and severe containment failure happen together.

Q.15 These arguments are important because errors of omission are one of the principal reasons for doubting reactor risk assessments. Please give some examples to illustrate your point.

A.15 Let us suppose that the PRA omitted a common cause failure mechanism that makes the simultaneous failure of all three auxiliary feedwater pumps ten times as likely as the PRA suggests. Such a mechanism might be sabotage in the pump room. This would have virtually no effect on core melt frequency or risk because there are alternative ways of cooling the core when all feedwater is lost, and other failure mechanisms that affect both auxiliary feedwater and these alternate ways are controlling. The competing accident scenarios that are modeled in the PRA would still dominate both core melt frequency and risk.

Now let us suppose that the omission in the risk assessment were a failure mechanism that can defeat all three auxiliary feedwater pumps and also all three high pressure injection pumps at the same time, again ten times as often as the PRA suggests. Although this hypothetical failure mode can give rise to core melt following a loss of main feedwater, the effect on core melt frequency and risk would still be small because other failure mechanisms that are modeled in the risk assessment, such as earthquake- or fire-induced failure of all cooling systems, are still more likely and more serious.

Let us take another example. Suppose there were an upset condition that the operators might misdiagnose, so that the operators turn off the core cooling systems that are really necessary to avoid a core melt. Suppose further that the operators do not recognize their error until the core melts.

Such scenarios, if they were not quite unlikely, could increase the frequency of severe core damage or core melt above that predicted in the IPPSS. On the other hand, it would have little effect on offsite radiological risk. Containment heat removal would not be defeated by this pattern of human error. There are no upset scenarios in which the operators would judge it desirable to turn off all the containment air coolers. In addition, the containment sprays would be operable. Once the operators saw the unmistakable symptoms of severe core damage - e.g., very high radiation levels in containment - they would almost certainly start the sprays or allow them to start automatically without interfering with them. With either the coolers or the sprays operating the radiation would be well-contained. The offsite radiological effects would be roughly those of the accident at Three Mile Island.

Q.16 Under what circumstances might errors of omission in the risk assessment lead to substantial underestimates of the risks to public health and safety?

A.16 Errors of omission in the catalog of accident sequences and in the estimation of their likelihood could lead to substantial underestimates of the risks to public health and safety only if the frequency of core melt accidents which occur in conjunction with gross containment failure were substantially underestimated. Very few of the places in the accident likelihood assessment where errors of omission might reside have this character. The principal exception is in the reliability models for the power supplies that serve the actuation and control of the active engineered safety features. A massive failure of safety feature actuation could turn a simple, common plant upset event into one of the more severe reactor accidents, although there would be a long time before the release would take place.

Some accounting for such accident scenarios is given in the IPPSS and a better treatment is given in NUREG/CR-2934, but we are not so confident that the treatment is comprehensive as we are for most other potentially high-risk scenarios.

See also the testimony of Bob Budnitz (seismic and hurricane risk) and Ben Buchbinder (fire risk) in Section IIIA of this testimony. The seismic, hurricane, and fire scenarios provide the dominant contributions to the projected reactor accident risks at Indian Point. Errors of omission in these analyses might also result in underestimates of the risk.

We believe that the great majority of the significant accident sequences have been identified and their likelihood correctly estimated. It is widely recognized, however, that some ways that faulted conditions in the plant can propagate among systems are quite subtle and hard to anticipate. This is the heart of the systems interaction issue. The Power Authority of the State of New York has underway a program to catalog and evaluate systems interactions in Indian Point Unit 3. It will provide and interesting benchmark on how thoroughly the IPPSS managed to identify and model the more important interactions. PASNY has projected a completion date of March, 1983 for their systems interaction study.

Q.17 What impact might arithmetic errors have on the accuracy of the risk predictions?

A.17 In principle, arithmetic errors could grossly distort the results. However, a significant distortion of the risk due to arithmetic errors in either the IPPSS or the staff calculations of risk would have been conspicuous in the comparison of the two studies and against the background of other PRAs and risk research. Thus, we need not count upon formal checking procedures to exclude the possibility that arithmetic errors are responsible for large distortions of the risk profile of the plant.

Q.18 Can an upper limit on the likelihood of severe reactor accidents be drawn directly from light-water reactor operating history?

A.18 Yes, such an upper limit can be calculated, but it is not rigorously applicable to either Indian Point unit. There has been over 500 reactor years of experience in the United States. Another 500 reactor years have been accumulated in foreign reactors having a design comparable to our domestic light water reactors. In the combined experience of 1000 reactor years, there have been no core melt accidents and only one instance of severe core damage, the accident at Three Mile Island. If the industry average frequency of core melt accidents were once in a thousand years or greater, we would have seen it by now. There would have been more close calls, instances of severe core damage, or even full core melts than have taken place. (See also my testimony on Board Question 1.2.)

Reactor risk assessments have predicted core melt frequencies in the range of once in a thousand reactor years down to once in several hundred thousand reactor years. Most cluster around once in ten thousand reactor years. Thus we can infer that if reactor risk assessments routinely under-predicted the likelihood of core melt by more than a factor of ten, we would have seen it by now.

These arguments suggest that the core melt frequency at each of the Indian Point plants is probably not much greater than 10^{-3} year. There are two weak spots in this logic, however. First, we have reason to believe that design differences do result in different plants having different core melt frequencies. Some plants are more susceptible than others. Second, the inference from industry experience presumes that the risk does not change with time. If the risk has declined with accumulated experience, the inference from the historical record is strengthened. If, on the other hand, wearout effects cause the risk to increase with time, the inference from industry experience is weakened. Up to this point, the risk has decreased with accumulated experience. We have no way to be sure that our increasing understanding of reactor safety and future improvements in the plants will outweigh the effects of aging, and so lead to declining risk, but it is my opinion that the risk will continue to decline.

Q.19 How might uncertainties in accident phenomena and releases of radiation affect the risk?

A.19 The uncertainties in accident processes tend to be predominantly pessimistic. It is unlikely that accident releases are as great as our model suggests; they cannot be very much larger. It is quite possible that they are substantially less. The effect of these biases is that the actual offsite radiological risks are likely to be less than we have modeled them to be.

Q.20 How did you arrive at this conclusion?

A.20 There are many known or suspected exaggerations of the risk in the calculations of the timing and quantity of fission products that would be released in severe reactor accidents. These exaggerations have been incorporated in Dr. Meyer's analysis in areas in which the experimental evidence is weak, to assure that it is quite unlikely that the release severity might be underestimated. Among the model assumptions that tend to exaggerate the severity of the release predictions are these:

1. The plateout of fission products released from melting reactor fuel on the inside of the reactor coolant system is ignored; it is all presumed to escape from the reactor coolant system.

2. The rate at which particulates in the containment atmosphere settle out - as modeled in Dr. Meyer's analysis - ignores the effect of agglomeration. Particles tend to adhere to one another and these larger, heavier particles settle out more rapidly than the smaller particles do individually.

3. The effectiveness with which water captures particulates and soluable fission products is treated conservatively. This is particularly important for those scenarios in which gasses from the melting or melted fuel percolate through water or the containment sprays operate.

4. No allowance has been made in Dr. Meyer's calculation for the filtering effect of leakage from the containment.

5. In many release scenarios, the gasses escaping from a leaking, ruptured, or bypassed containment would be released inside the Primary Auxiliary Building. No plateout, filtration, or fallout of fission products within the auxiliary building is assumed.

6. Most measures of offsite radiological risk (delayed health affects and property damage in particular) are dominated by accidents that progress through what Dr. Meyer has labeled Damage State E. These accidents entail failure of all heat removal systems - both core cooling and containment cooling systems. Dr. Meyer's analysis of the containment response to damage state E falls at the threshold between severe and benign containment failure modes. It is a borderline case whether the containment fails due to overpressure or succeeds in bottling up the fission products, gases, and steam. Dr. Meyer's best estimate suggests that 40% of these events produce gross overpressure failures of containment about 11 hours after core melt, and that 60% of these events produce very modest atmospheric releases. There is a delicate balance in this analysis in which the pressure of the gases within containment may hover for some time near the failure pressure of the containment. Small uncertainties in the calculation could throw the result toward 100% overpressure failure or 100% benign releases. In the former case, most measures of risk would increase by as much as a factor of 2.5; in the latter case most measures of risk would fall by a factor of roughly 100, i.e. to 1% of the predicted values. Thus, Dr. Meyer's central estimate, and the staff testimony on risk, is biased toward the pessimistic end of this particular band of uncertainty.

An alternative outcome for long-delayed overpressure failure of containment is the possibility that the containment might develop a slow leak a few hours or tens of hours after core melt that would suffice to prevent gross overpressure rupture. In this case the timing of the release would agree roughly with the staff calculations for late overpressure failure, but the quantities of fission products released would be less in total and very much more gradual than our model suggests.

Q.21 How do you know that the severity of releases could not be very much greater then the staff testimony suggests?

A.21 The staff testimony suggests that a very severe release takes place in roughly one out of three core melt accidents, and that a large fraction of those radioactive materials available for release are released. Even if all these materials were released in every core melt, the risk would not be more than about a factor of 10 higher than our testimony suggests. On the other hand, it is quite plausible that severe releases take place in less than 1% of core melt events, and that the severe accidents entail releases of smaller fractions of the core inventory.

Q.22 What are the effects of uncertainties in the staff consequence analysis upon the projected risk?

A.22 Among the principal contributors to the uncertainty in consequence analysis are the assumed particle size for particulate releases, the fluid-dynamics of plume rise and the possibility of spontaneous plume rain, dispersion parameterization, deposition modeling, dosimetry and health effects modeling. Section IIIC describes the uncertainties in greater detail. For a more extensive treatment of uncertainties in consequence modeling see Chapter 9 of NUREG-2300.

Q.23 In light of all these uncertainties, what do you judge the accuracy of the bottom line risk predictions to be?

A.23 I think it important to communicate my judgment of the range of uncertainty, but I do not want to portray it as anything more objective than my judgment. I arrive at a judgment of the range of possible error in the bottom-line risk predictions as follows.

I would be mildly surprised, but not very surprised, if the likelihood of the more severe releases of radiation which drive the offsite radiological risk were in error by a factor of 30 (higher) or 1/30 (lower). This can be portrayed as an uncertainty factor of $10^{\pm 1.5}$. Likewise for the quantity of fission products that might be released to the atmosphere in these accidents might range from 3 times our estimate to 1/30 of our estimate ($10^{-.5\pm 1.0}$). The several kinds of consequences have some what different uncertainty factors, but most, I believe, are predicted within a factor of 10 of the correct value, or better ($10^{\pm 1.0}$). Since risk is obtained by multiplying the likelihood by the severity of release and multiplying that by the consequences of the release, the uncertainty factors are also multiplicative.

The risk uncertainty factor is thus $10^{-.5\pm 1.5\pm 1.0\pm 1.0}$.

The three uncertainty contributors are uncorrelated so that the combined uncertainty can be estimated as the square root of the sum of the squares of the contributors:

$$\sqrt{(1.5)^2 + (1.0)^2 + (1.0)^2} = \sqrt{4.25} = 2.1$$

Thus I judge the uncertainty of our bottom line risk predictions to be roughly $10^{-.5\pm2.1}$, that is I would be mildly surprised, but not very surprised if our estimates of offsite radiological risks were too low by a factor of 40 ($10^{+1.6}$) or too high by a factor of 400 ($10^{-2.6} = 1/400$).

PROFESSIONAL QUALIFICATIONS
FRANK H. ROWSOME, 3rd
U.S. NUCLEAR REGULATORY COMMISSION

I am Frank H. Rowsome, 3rd, Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research. I have served in that capacity since joining the NRC in July 1979. The work entails planning, budgeting, managing and staffing the Division. Much of the work of the Division is devoted to research in reactor accident risk assessment. The remainder entails risk assessment applied to non-reactor aspects of the nuclear fuel cycle and to standards development related to system reliability or risk.

I received a bachelor's degree in physics from Harvard in 1962. I studied theoretical physics at Cornell, completing all requirements for a Ph.D except for the dissertation in 1965. From 1965 to 1973, I taught and engaged in research in theoretical physics at several colleges and universities.

In 1973 I joined the Bechtel Power Corporation as a nuclear engineer. My initial assignment was to perform accident analyses for nuclear plant license applications. After six months in that job, I was transferred to a newly formed group of systems engineers charged with developing for Bechtel a capability to perform risk assessments and system reliability analyses of the kind the NRC was then developing for the Reactor Safety Study. In that capacity I performed reliability analyses of nuclear plant safety systems, developed computer programs for system reliability analyses, performed analyses of component reliability data, human reliability analyses, and event tree analyses of accident sequences. I progressed from nuclear engineer, to senior engineer, to group leader, to Reliability Group Supervisor before leaving Bechtel to join the NRC in 1979. In this last position at Bechtel, I supervised the application of engineering economics, reliability

engineering, and analysis techniques to power plant availability optimization as well as nuclear safety analysis.

While serving as Deputy Director of the Division of Risk Analysis (and its anticedent, the Probabilistic Analysis Staff), I also served as Acting Director (7 months), acting chief of the Reactor Risk Branch (9 months) and acting chief of the Risk Methodology and Data Branch (4 months).

This experience has given me the practitioner's view as well as the manager's view of those facits of reactor risk assessment entailing the classification of reactor accident sequences, system reliability analysis, human reliability analysis, and the estimation of the likelihood of severe reactor accidents. I have the manager's perspective but not the practitioner's experience with those facits entailing containment challenge analysis, consequence analysis, and risk assessment applied to other parts of the nuclear fuel cycle.

My role in the development of testimony for this hearing has been as coordinator of the preparation of testimony on risk and one of the coordinators of the technical critique of the licensee's "Indian Point Probabilistic Safety Study." I am not an expert on the design or operation of the Indian Point plants.

List of Publications

1. "The Role of System Reliability Prediction in Power Plant Design," F.H. Rowsome, III, Power Engineering, February 1977.

2. "How Finely Should Faults be Resolved in Fault Tree Analysis?" by F.H. Rowsome, III, presented at the American Nuclear Society/Canadian Nuclear Association Joint Meeting in Toronto, Canada, June 18, 1976.

3. "The Role of IREP in NRC Programs" F.H. Rowsome, III, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

4. "Fault Tree Analysis of an Auxiliary Feedwater System," F.H. Rowsome, III, Bechtel Power Corp., Gaithersburg Power Division, F 77 805-5.

BY MS. MOORE: (Resuming)

Q Mr. Rowsome, do you have in front of you a copy of a document entitled Direct Testimony of Frank H. Rowsome to Contention 1.1 and Board Question 1.1?

A (WITNESS ROWSOME) Yes.

Q Was this testimony prepared by you?

A (WITNESS ROWSOME) Yes.

Q Do you have any additions or corrections to this testimony?

A (WITNESS ROWSOME) Yes. Page 5 --

MS. MOORE: Your Honor, would you like for us to wait until you have found it?

JUDGE GLEASON: No, that is all that is left. We have already found it. Go ahead.

WITNESS ROWSOME: Page 5, the big paragraph, the sixth line now reads "Rise to accidents characterized by 100 or more early fatalities." Delete the "I."

Same page, five lines up from the bottom, there is a number in the righthand side of the page, 7,500. That should be 28,500.

Page 7, next to the bottom line, "exposure," the vowel "o" got lost.

That completes my corrections.

BY MS. MOORE: (Resuming)

Q With these changes in your testimony, is it true and correct to the best of your knowledge, information, and belief?

A (WITNESS ROWSOME) Yes.

Q Do you adopt this as your testimony in this proceeding?

A (WITNESS ROWSOME) Yes.

MS. MOORE: Copies of this testimony have been delivered to the Board, the parties, and the Court Reporter. I ask that the testimony be admitted into evidence and bound into the record as though read.

JUDGE GLEASON: Is there objection?

(No response.)

JUDGE GLEASON: Hearing none, the testimony will be received into evidence and bound into the record as if read.

(The prepared testimony of Mr. Rowsome follows.)

(V)

#7

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CONSOLIDATED EDISON OF NEW YORK (Indian Point, Unit 2)	)	Docket Nos. 50-247-SP 50-286-SP
	)	
POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit 3)	)	

DIRECT TESTIMONY OF FRANK H. ROWSOME TO CONTENTION 1.1 and BOARD QUESTION 1.1

Q.1 State your name and position with the NRC.

A.1 My name is Frank H. Rowsome. I am Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research.

Q.2 What are your responsibilities in that position?

A.2 I assist the Director in planning and managing the research group in risk assessment, probabilistic safety analysis, operations research, reliability engineering, and related regulatory standards development.

Q.3 Have you prepared a statement of your professional qualifications?

A.3 Yes, the Statement of my professional qualifications is attached to this testimony.

Q.4 What is the purpose of this testimony?

A.4 The purpose of this testimony is to respond to Contention 1.1, provide an outline of where the staff response to Board Question 1.1 can be found.

Q.5 How does Contention 1.1 read?

A.5 Contention 1.1 reads as follows:

> The probabilities and consequences of accidents at Indian Point Units 2 and 3 combine to produce high risks of health and property damage not only within the plume exposure EPZ but also beyond the plume exposure EPZ as far as the New York City metropolitan area.

Q.6 What is your summary response to Contention 1.1?

A.6 The Staff testimony in Section III above identifies that there are risks, but the adjective "high" is not warranted.

Q.7 What is the basis for that conclusion?

A.7 The risks would deserve to be called high risks, in my judgment, if they loomed large against the background of competing non-nuclear risks.

Q.8 How do the annual average risks compare with background risks?

A.8 The annual average early fatality risk for the site, evaluated "after fix", i.e. as the plants will be designed and operated in 1983, with the evac/reloc - late reloc model, amount to 0.019 early fatalities per year. Within 50 miles of the site there are roughly

15 million people (see Len Soffer's testimony in Section III). The average U.S. individual risk of accidental death from all causes averages $5x10^{-4}$ per person per year. (See NUREG-0880 p. 22). Thus, the background risk of accidental death in the region is roughly 7500 per year. Therefore the contribution to the risk of early accidental death posed by severe reactor accidents at the two Indian Point Units represents roughly 2.5 parts per million of the background risk averaged over a 50 mile radius of the plant.

The annual average risk of doses which would ultimately lead to cancer fatalities posed by severe reactor accidents at Indian Point amounts to 0.32 cancer fatalities per site year, total (i.e. from all distances from the plant and counting both units). Roughly 19 persons per 10,000 population die annually in the U.S. as a result of cancer. (See NUREG-0880 p. 23). Thus, we expect a background risk of roughly 28,500 cancer fatalities per year within 50 miles of the site. The severe reactor accident contribution to the cancer fatality risk thus amounts to roughly 11 parts per million of the background risk.

The annual average property damage risk for the two unit site amounts to $450,000 per year. We have not developed a realistic estimate of the background economic loss rate within 50 miles of the site, but it is clear that a wide variety of accidental hazards pose economic loss rates well in excess of this rate.

Thus I conclude that the annual average risks posed by severe reactor accidents at Indian Point Units 2 and 3 would not loom large against the background of competing risks, even if our reactor risk estimates were substantially underestimated.

Q.9 How do the risks posed by severe reactor accidents at Indian Point Unis 2 and 3 compare with the background of rare, high consequence risks?

A.9 Dr. Acharya's table IIIC5 shows the number of casualities to be expected if a severe reactor accident were to occur, in each of the several release categories. For some of the release categories, particularly release categories H and I, we expect no early fatalities at all, under any weather conditions. For the more severe but still comparatively probable release category C we expect no early fatalities if evacuation is feasible and early fatalities in the hundreds for earthquake - triggered ocurrences. Even for the especially rare, high consequence release categories A and B we expect early fatalities in the thousands, not tens of thousands. These particularly severe releases have occurrence intervals estimated to be less than once in a million reactor years.

The background or non-nuclear risk of events producing accidental deaths in the hundreds or thousands was calculated for the Reactor Safety Study. See Figures 6-1 and 6-2 in the Main Report (pp. 119-120). Nationally, the frequency of man-caused accidents that kill 100 or more people is roughly 0.7 per year.

The corresponding frequency of man-caused accidents that kill 1000 (10,000) or more is roughly 0.05 (.004) per year.

Although only a portion (of the order of one percent) of this background of man caused multi-fatality accident risk is applicable within fifty miles of the site, it is still far larger than the frequencies found in Dr. Acharya's testimony. See also, Figure IIIC1 which indicates that Indian Point Unit 2 can be expected to give rise to accidents characterized by 100 or more early fatailities with frequency of three per million years. Similarly the frequencies for accidents with 1000 or more (10,000 or more) early fatalites in Figure IIIC1 is $2x10^{-6}$ ($5x10^{-7}$) per year. The frequency of still more severe accidents declines quite rapidly above that consequence level. I am lead to conclude that among rare man-caused accidents having early fatalities in the hundreds or more, the contribution posed by severe reactor accidents at Indian Point is quite small. Dr. Acharya's Table IIIC5 shows expected cancer fatalities in the range tens to thousands for the several release categories. These cancer fatalities do not occur in one year but are the cumulative totals for roughly 40 years after the hypothetical accident. These can be compared with the uniform background of roughly 7500 cancer fatalities per year to be expected within 50 miles in any case. Thus, we can conclude that even if such an accident were to occur, the increment in the cancer rate each year would not loom large against the non-nuclear background cancer fatality rate.

Note that a large part of the severe accident risk posed by Indian Point Units 2 and 3 originate in accidents triggered by earthquakes and hurricanes. Earthquakes or hurricanes of the severity sufficient to cause a severe reactor accident at Indian Point would constitute regional disasters of far broader extent than the effects of the radioactive plume. The Staff has not developed a non-nuclear risk assessment for these events, but it seems plausible to us that the casualties and property damage associated with these trigger events would exceed those attributable to the nuclear component of the disaster.

In short, we do not see severe reactor accidents as potentially looming large against the background of competing risks.

Q.10 Is this piece of testimony meant to reflect the Staff position on acceptable risk?

A.10 No, it is merely meant to address Contention 1.1. We shall deal with the implications of the risk assessments for regulatory action in the testimony to be filed on Commission Question 5.

Q.11 What is the first basis for Contention 1.1 in the Board Order of November 15, 1982?

A.11 The first basis for Contention 1.1 reads:

> 1) The risk of injurious health effects to people in the plume exposure EPZ from excessive exposure to radiation, as a result of accidents, will be exacerbated by an impeded evacuation because:

a) Licensees have failed to demonstrate that proper emergency action levels (EAL's) as required by 10 C.F.R. § 50.47(b)(4) have been established which will allow prompt recognition of the range of possible accidents at Indian Point Units 2 and 3 and prompt and correct diagnoses of such accidents for the recommendation of appropriate protective actions (UCS/NYPIRG 1B5); and

b) Licensees have failed to provide instrumentation in accordance with Reg. Guide 1.97, Rev. 2, thus compromising their ability to adequately monitor the course of accidents at Indian Point Units 2 and 3 (UCS/NYPIRG IB5);

Q.12 What is the Staff's view of this basis?

A.12 Our risk analysis suggests that evacuation of the plume exposure EPZ will be impeded, for the risk dominent accident scenarios, though not for the reasons cited in the basis. Rather, a large part of the risk originiates in accidents triggered by earthquakes or hurricanes. As noted in Staff testimony sections IIIC and IVB above, these trigger events constitute regional disasters that can impede evacuation. Therefore we believe the sub-basis a) and b) to be moot. For the reasons developed above, we do not feel that i ded evacuation leads to "high" risks.

Q.13 What is the second basis for Contention 1.1 in the Board Order of November 15, 1982?

A.13 The second basis reads:

2) A risk of health and property damage as a result of accidents extends beyond the plume expsure EPZ to the New York City metropolitan area because:

a) under certain meteorological conditions, life-threatening doses would occur in the New York City metropolitan area for a WASH-1400, PWR-2 type accident (UCS/NYPIRG IIID), and there are no areas which would adequately protect the public health and safety in such circumstances (UCS/NYPIRG IIID, FOE/Audubon I, basis 7); and

b) contamination of the Hudson River would affect beaches as far away as Coney Island and Rockaway Beach (See NUREG-0850, Vol. I, Preliminary Report, Appendix D) (UCS/NYPIRG IVA).

Q.14 Where, in the Staff testimony are the issues raised in sub-basis 2a treated?

A.14 The range of life-threatening doses can be found in the testimony of Dr. Acharya in section IIIC, see also IVB. See also the testimony of Roger Blond on Board Question 1.3 below.

Q.15 Where, in the Staff testimony, are the issues raised in sub-basis 2b treated?

A.15 See the testimony of Richard Codell on Section IIID of the Staff testimony.

Q.16 Does this conclude your testimony on Contention 1.1?

A.16 Yes, though my testimony on Board Questions 1.1 and 1.2 follow.

Q.17 How does Board Question 1.1 read?

A.17 Board Question 1.1 reads:

> What are the consequences of serious accidents at Indian Point and what is the probability of occurrence of such accidents? In answering this question the parties shall address at least the following documents: (a) the Indian Point Probabilistic Safety Study (IPPSS) prepared by the Licensees; (b) the Sandia Laboratory "Letter Report on Review and Evaluation of the Indian Point Probabilistic Safety Study" (Letter Report), dated August 25, 1982; and (c) any other reviews or studies of the IPPSS prepared by or for the Licensees, the NRC Staff, or the Intervenors, or any other document which addresses the accuracy of the IPPSS.

Q.18 Where, in the Staff testimony, are these issues addressed?

A.18 See testimony section III. The whole of the section is material to the Staff assessment of accident likelihood, severity and/or consequences. In addition, the IPPSS, the current (final) version of the Sandia Letter Report, NUREG/CR-2934, and Staff critques thereof are dealt with in testimony section III. Note that testimony section IVC also includes a critique of certain aspects of the IPPSS uncertainty analysis.

Q.19 Does this conclude your testimony on Board Question 1.1?

A.19 Yes.

PROFESSIONAL QUALIFICATIONS
FRANK H. ROWSOME, 3rd
U.S. NUCLEAR REGULATORY COMMISSION

I am Frank H. Rowsome, 3rd, Deputy Director of the Division of Risk Analysis in the Office of Nuclear Regulatory Research. I have served in that capacity since joining the NRC in July 1979. The work entails planning, budgeting, managing and staffing the Division. Much of the work of the Division is devoted to research in reactor accident risk assessment. The remainder entails risk assessment applied to non-reactor aspects of the nuclear fuel cycle and to standards development related to system reliability or risk.

I received a bachelor's degree in physics from Harvard in 1962. I studied theoretical physics at Cornell, completing all requirements for a Ph.D except for the dissertation in 1965. From 1965 to 1973, I taught and engaged in research in theoretical physics at several colleges and universities.

In 1973 I joined the Bechtel Power Corporation as a nuclear engineer. My initial assignment was to perform accident analyses for nuclear plant license applications. After six months in that job, I was transferred to a newly formed group of systems engineers charged with developing for Bechtel a capability to perform risk assessments and system reliability analyses of the kind the NRC was then developing for the Reactor Safety Study. In that capacity I performed reliability analyses of nuclear plant safety systems, developed computer programs for system reliability analyses, performed analyses of component reliability data, human reliability analyses, and event tree analyses of accident sequences. I progressed from nuclear engineer, to senior engineer, to group leader, to Reliability Group Supervisor before leaving Bechtel to join the NRC in 1979. In this last position at Bechtel, I supervised the application of engineering economics, reliability

engineering, and analysis techniques to power plant availability optimization as well as nuclear safety analysis.

While serving as Deputy Director of the Division of Risk Analysis (and its anticedent, the Probabilistic Analysis Staff), I also served as Acting Director (7 months), acting chief of the Reactor Risk Branch (9 months) and acting chief of the Risk Methodology and Data Branch (4 months).

This experience has given me the practitioner's view as well as the manager's view of those facits of reactor risk assessment entailing the classification of reactor accident sequences, system reliability analysis, human reliability analysis, and the estimation of the likelihood of severe reactor accidents. I have the manager's perspective but not the practitioner's experience with those facits entailing containment challenge analysis, consequence analysis, and risk assessment applied to other parts of the nuclear fuel cycle.

My role in the development of testimony for this hearing has been as coordinator of the preparation of testimony on risk and one of the coordinators of the technical critique of the licensee's "Indian Point Probabilistic Safety Study." I am not an expert on the design or operation of the Indian Point plants.

List of Publications

1. "The Role of System Reliability Prediction in Power Plant Design," F.H. Rowsome, III, Power Engineering, February 1977.

2. "How Finely Should Faults be Resolved in Fault Tree Analysis?" by F.H. Rowsome, III, presented at the American Nuclear Society/Canadian Nuclear Association Joint Meeting in Toronto, Canada, June 18, 1976.

3. "The Role of IREP in NRC Programs" F.H. Rowsome, III, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

4. "Fault Tree Analysis of an Auxiliary Feedwater System," F.H. Rowsome, III, Bechtel Power Corp., Gaithersburg Power Division, F 77 805-5.

MS. MOORE: Your Honor, having waived the summary statements, the witnesses are now available for cross examination.

JUDGE GLEASON: Mr. Blum.

CROSS EXAMINATION ON BEHALF OF UCS

BY MR. BLUM:

Q The questions which follow will be directed initially to Mr. Rowsome, although in general we are always happy to hear from Mr. Blond, and if he wishes to add something, he may.

JUDGE GLEASON: Could you make sure that you outline which pieces of testimony the questions will be referred to?

MR. BLUM: You are asking me to differentiate?

JUDGE GLEASON: I am just asking that if you are going to jump from one piece of testimony to the other, would you please let us know at the time?

MR. BLUM: Oh, all right.

JUDGE GLEASON: Are your questions now in the summary response area?

MR. BLUM: The problem I have found is that conceptually the different pieces of testimony overlap to a great degree. Some of them overlap completely, and a lot of the questions just are directed to more than one at the same time.

JUDGE GLEASON: We will struggle with you. Please proceed.

MR. BLUM: Thank you.

BY MR. BLUM: (Resuming)

Q Mr. Rowsome, in general, it is true that the more work that is done with probabilistic risk assessment, the more we learn about the kinds of results that are coming out of PRA's. Is that not true?

A (WITNESS ROWSOME) That is generally true, yes.

Q We learn -- Included in what we learn are some things about the range of uncertainties, and also about limitations of particular PRA's?

A (WITNESS ROWSOME) Yes.

Q And, for example, PRA's or different methodologies can be used in some sense to cross-check one another and to reveal weaknesses in one another. Is that not true?

A (WITNESS ROWSOME) That is true.

Q Could you give us some instances of where PRA's using somewhat different methodologies from IPPSS reveal limitations in IPPSS?

A (WITNESS ROWSOME) Well, I believe the methods used in the IREP studies for event tree, fault tree analysis are capable of revealing some subtle kinds of -- well, literally, they are cut sets of failure mechanisms of interdependent lattice systems that the method employed by Pickard, Lowe, and Garrick for IPPSS might not have discovered.

Q So you are saying there are particular cut sets that were omitted?

A (WITNESS ROWSOME) I don't know that they were important cut sets that were omitted, but I believe that the IREP methodology is a more penetrating way of discovering them.

Q Are you now referring to forms of systems interaction in your answer?

A (WITNESS ROWSOME) It could be called that. I try to avoid using that term when I can, because it means so many different things to so many different people.

Q Will you please pick a term that you think is a better one for what you are talking about and explain it some?

A (WITNESS ROWSOME) Well, let me give you an example from my own experience. I once did a fault tree analysis of a group of interdependent systems. I started with the front line system, and proceeded to model in the fault tree all of the auxiliary systems on which it depended, and in so doing I created a model of the system from which I could draw cut sets in the technical phrase and failure modes in the layman's sense.

I discovered some I would never have anticipated were present if I had had to judge what the important failure modes of the system were. Just reading system descriptions, it would not have dawned on me that some of the failure modes in the system that were revealed by my fault tree map were in fact there. Having discovered them through the fault tree, I then thought them through and verified that they were in fact failure modes of this network of systems.

The method employed by Pickard, Lowe, and Garrick, to use large event trees and small fault trees, as Mr. Weatherwax, I believe, pointed out, is based upon the premise that you have anticipated and modeled in the event tree the important interdependencies of systems. That premise would in my example have blinded me to the discovery of that interdependence or of those surprising failure modes.

Q So in the case of IPPSS, we don't know what may have been overlooked by this assumption.

A (WITNESS ROWSOME) We can classify it pretty well. We know they did a pretty careful job of piecing out the combinations and permutations of the power available or unavailable on the essential switch gear buses. They had, I think, five, maybe, or more states that they discriminated. However, they did not discriminate in the event trees, every permutation and combination of live or dead essential switch gear buses and EC buses and service water trains and component cooling water trains and so forth, so that it is conceivable, although I don't think terribly likely, that there might be some surprises lying in that arena.

Q Are there any ways in which types of PRA methodology that are more sensitive to significant initiating events might reveal -- the comparison of that with IPPSS, might reveal some limitations in IPPSS?

A (WITNESS ROWSOME) It doesn't come to mind. I can't say yes to that question. I don't have any such a conception in mind.

Q Well, are there any other kinds of limitations of the IPPSS methodology that you are aware of that would relate to what you are talking about?

A (WITNESS ROWSOME) That is an immensely general question. Do you want to focus in on something in particular?

Q Well, all right. Is there anything more that you would have to say now about completeness uncertainty in IPPSS?

A (WITNESS ROWSOME) Well, my testimony in IV.C was meant to talk about uncertainty in the staff testimony. I really didn't take on the question of uncertainties in the IPPSS.

Q Well, then, let me, if you would like -- could you identify -- when you say the staff testimony, are you referring to the parts of the staff testimony that the staff genuinely did its own calculations, for example, in containment response and consequence modeling? Or are you referring to the Sandia review of the plant analysis in IPPSS?

A (WITNESS ROWSOME) IV.C was my attempt to describe qualitatively in it, not just quantitatively, the uncertainties in the staff answer to Commission Question 1 and Board Question 1.1. I did mention IPPSS in passing, but it was not my objective there to try to do comprehensive testimony on the uncertainties in IPPSS.

Q Well, what would you see as the major uncertainties in the containment analysis that the staff has done?

A (WITNESS ROWSOME) Jim Meyer will be very much better able to address that than I. I think what I am able to do I did in the text here. Let me see if I can find the right Q's and A's.

I think it starts Question 19, and runs through Question 21.

Q So you are saying all you can do is provide this general description, and that further elaboration should be done by Jim Meyer. Is that correct?

A (WITNESS ROWSOME) That's right.

Q Thank you.

I would like to ask you some further explanation of some of the things that you said in your Answer 9 of this testimony. For example, the concluding sentence of Answer 9, where you say the judgmental treatment of uncertainties in the quantities of radioactive material released and the consequences of releases employed in the U factors in the level 2 analysis in IPPSS is quite simplistic, though not necessarily in error, could you tell us first what the U factors refer to?

A (WITNESS ROWSOME) They were factors that were folded into the Bazian combination, actually, the numerical integration of the uncertainty distributions arising from initiating events, system reliability, containment analysis, and consequence analysis.

Q So you are saying these are the input numbers rather than a mathematical technique itself?

A (WITNESS ROWSOME) The U factors themselves were input numbers. That's right.

Q And why do you say that they were simplistic?

A (WITNESS ROWSOME) Well, they were intended to envelope a great many contributors to either uncertainty or, in the case of source terms, anticipation of a shift in what the right answer would be, and since there was such a rich variety of considerations that were supposed to be swept up by this simple factor or array of factors, that while there is no particular reason to believe it is wrong, there is not much evidence that it is right, either.

Q When you say not much evidence that it is right, what evidence is there?

A (WITNESS ROWSOME) I think the IPPSS people are better able to defend that than I. I wouldn't have chosen to do it that way.

Q Why would you not?

A (WITNESS ROWSOME) I suppose I could have if my objective were an attempt to give optimum realism to the calculation, though I would have much preferred to have fleshed out some of the mechanisms underlying the shifts and uncertainties that were swept up in the U factor. Generally, within the NRC, we tried to use the least amount of conservatism we feel comfortable with justifying. That is, we put in acknowledged conservatisms to the extent that we feel fairly comfortable that we have not been overoptimistic, if you will.

And so, in a PRA done to have some bearing on the regulatory process for some possible use in regulatory decision-making, we prefer to approach things that way, with that minimum practical conservatism, rather than with judgmental guestimates of how much better things might be.

Q In the early part of your answer, am I correct that one of your major criticisms of the treatment of uncertainties in IPPSS is, they were rather opaque about how these particular numbers for uncertainty were arrived at?

A (WITNESS ROWSOME) They were somewhat opaque, but really a large part of that originates from the fact that they were acknowledged to be subjective.

Q Well, how does the subjectivity of it translate into opaqueness?

A (WITNESS ROWSOME) Well, I didn't mean to imply that it did. I meant that my reservation about that uncertainty treatment relates as much or more to its subjectivity as its opaqueness.

JUDGE GLEASON: Mr. Blum, when you referred to the earlier part of Mr. Rowsome's answer, are we still on question 9?

MR. BLUM: No, I'm sorry. It was the earlier part of the answer he gave in his testimony under cross-examination. Excuse me.

JUDGE GLEASON: I see.

BY MR. BLUM: (Resuming)

Q So your complaint, your principal complaint, even more than with the opaqueness, then, is with the subjectivity of the estimates; am I correct now?

A (WITNESS ROWSOME) I think we need more of a frame of reference for such questions to make sense. Were we to adopt the IPPSS for regulatory decisionmaking within the Commission, we would have some objection about depending upon the educated judgment of the IPPSS team. We would rather see more objective bases for the result.

On the other hand, as an attempt by the Licensees to give their best judgment of what the risks are, it is quite a reasonable way to proceed.

Q Thank you.

You stated in your deposition earlier that different types of uses of PRA's exercised their strengths and weaknesses in different ways?

A (WITNESS ROWSOME) Yes.

Q Would you care to elaborate on that with regard to the weaknesses? What kinds of uses are you aware in some sense exacerbate the weaknesses, as opposed to what kind of uses minimize them?

MS. MOORE: Mr. Chairman, I really think this is somewhat beyond the scope of Mr. Rowsome's testimony. The uses of PRA, the strengths and weaknesses, were discussed in the introductory testimony.

JUDGE GLEASON: Well, I think he's all over the lot. Go ahead.

BY MR. BLUM: (Resuming)

Q Go ahead, please.

JUDGE GLEASON: Now, I said I think your questions are not confined to particular sections of the testimony. They are all over the lot. I use that in a general sense. Am I correct?

MR. BLUM: Well, what happened when we were correcting Dr. Rowsome on the introductory testimony, it was noted that there was substantial conceptual overlap between that and this piece of testimony, and a decision was made then that we should stop at that point and put it all in under this testimony because this was the more substantial, detailed testimony.

JUDGE GLEASON: I'm not criticizing. I'm just trying to find out where it's going. The objection is your question is beyond the scope of any of the testimony.

MS. MOORE: Mr. Chairman, I believe as I understood what happened when the introductory testimony was put in, it was that Mr. Blum had some questions and uncertainties, and we said at that time that uncertainties should be dealt with later. But these questions are much more general than uncertainties. It is back to the strengths and weaknesses of PRA, which I believe was essentially covered in the introduction.

MR. BLUM: Well, perhaps if I rephrase the question it would help.

BY MR. BLUM: (Resuming)

Q Instead of speaking about the strengths and weaknesses of PRA's, there are some uses of PRA's where the uncertainties become more problematic and where they are more troublesome than with other uses, is that not true?

A (WITNESS ROWSOME) That is true.

Q Could you address this with regard to some of the situations where the uncertainties become more troublesome to you?

A (WITNESS ROWSOME) I'd be happy to go where you want me to go, because it's already on the record in response to a question by Judge Shon a week ago, and that is that to use a PRA bottom line as though it were a precise number to measure compliance against a hypothetical criterion of acceptable risk would be a little previous.

We don't have that kind of accuracy.

Q And you believe we are in better shape when we're using PRA's to trace out what types of improvements are more worth making than other types of improvements?

A (WITNESS ROWSOME) That is correct.

Q Thank you.

In your testimony you state that modeling approximations are almost always taken in a pessimistic direction, do you not?

A (WITNESS ROWSOME) That's right.

Q Wouldn't that principally be true of the modeling approximations that we subsequently become aware of as approximations? That is, our process of becoming aware of them tends to help us identify those which were overly pessimistic?

A (WITNESS ROWSOME) Yes.

Q And it would be less true of modeling approximations that we never catch; we are less likely to know which direction those went in?

A (WITNESS ROWSOME) Well, it is kind of a semantic distinction, whether you call those completeness problems or modeling approximations. But I will grant it to you.

Q I see. Well, when you use the term "completeness omissions" -- strike this question. There's a point to be made, but I don't think it's worth the amount of time that it would take for us to get to it.

Are you aware of studies which have identified particular types of human error where a single error could lead directly to core melt?

A (WITNESS ROWSOME) A single human error leading directly to core melt? Well, a single pattern of human error, yes, I could think of one instance.

Q Did you know of a particular study which addressed this problem?

A (WITNESS ROWSOME) I did one such study, although I don't know that it's been published.

Q Now we are referring simply to published studies.

A (WITNESS ROWSOME) I don't know that one has been published that identified a human error, single, that would get you to core melt.

Q With regard to your unpublished study, what was the one that you identified there?

A (WITNESS ROWSOME) Back when I was working for industry, I was tasked with doing a study that was requested by the Commission of the licensee for whom my company then, Bechtel, was the architect-engineer.

Q With regard to different uses of PRA again, you stated previously, have you not, that it would be a misuse of PRA to take two PRA's, for example, with different source term estimates and to use those to effect a direct comparison between two plants?

MR. BRANDENBURG: I object, Mr. Chairman. I think that mischaracterizes the witness' prior testimony.

MR. BLUM: I'm sorry. This was in his deposition that that was said.

JUDGE GLEASON: Well, you ought to identify that.

BY MR. BLUM: (Resuming)

Q In your deposition, Dr. Rowsome, Mr. Rowsome, do you remember making that statement?

A (WITNESS ROWSOME) I remember saying that plant to plant comparisons of the source term was a non-issue since the source term would be comparable, shared by each plant in comparison.

Q You're saying if, if that was true it would be a non-issue?

A (WITNESS ROWSOME) That's right.

Q However, if it were not true, if for one plant one kind of source term were used and for another plant a significantly different kind were used, it would be a misuse of PRA to draw a direct comparison of those two results for those two plants?

A (WITNESS ROWSOME) Without acknowledging and accounting for the difference in source terms, that might be so, yes.

Q This would be true for other types of differences in either input data or modeling that could significantly affect the outcome?

A (WITNESS ROWSOME) It sounds to me like you're asking question 5 questions, but yes.

Q Thank you.

With regard to your testimony, you make reference to Dr. Easterling's discussion of Bayesian statistics, do you not?

A (WITNESS ROWSOME) I may have done. I know I referred to his recalculations of some accident sequence likelihoods.

Q And you are aware that Dr. Easterling is not making the point that the Bayesian methods were misused in IPPSS?

A (WITNESS ROWSOME) That is my understanding, yes, you are right.

Q But that Dr. Easterling is making the point that with Bayesian methods there is a substantial risk of uncertainties being masked to some extent?

A (WITNESS ROWSOME) The community of statisticians are drawn into two or more camps of intensely hostile partisans of one approach or the other. I myself am not a partisan in this struggle, and I think it useful, as we did in fact, to have partisans of each kind do the calculation of the statistics, to calculate accident sequence likelihoods. And if they come up with essentially the same answer, I conclude that the statistical issue was a non-issue, and if they come up with significantly different issues I want to find out why.

That didn't seem to be a problem in this instance.

JUDGE PARIS: In this instance they came up with consistent answers?

WITNESS ROWSOME: That's right.

BY MR. BLUM: (Resuming)

Q But you are aware that the different methods they used were simply to recalculate using only the plant-specific data and not the prior data; is that correct?

A (WITNESS ROWSOME) The recalculations were done with industry data, but pure data and not somebody's judgmental priors. There were no priors involved, but the data base was industry, generic.

Q Oh, I see. So it was all kinds of data were used, but what was simply excluded by Dr. Easterling was the judgmental prior as opposed to data; is that correct?

A (WITNESS ROWSOME) That's right.

Q So using Dr. Easterling's approach to check it, things would check out fine as long as the judgmental priors came out similar to the data?

A (WITNESS ROWSOME) That's right.

Q And that similarity could be arrived at by any number of means?

MS. MOORE: Mr. Chairman, I object. I believe this is beyond the scope. Dr. Easterling was here and I think it would have been better to ask him.

MR. BLUM: I don't think it's beyond the

scope, but I'd be willing to withdraw the question anyway, just to speed us along.

BY MR. BLUM: (Resuming)

Q Well, let me ask a question of Mr. Blond so that he doesn't get too bored.

In the summary testimony you draw some comparison about the risks of Indian Point with the risks to individuals in a 50-mile radius around Indian Point from other causes, is that not correct?

A (WITNESS BLOND) I'm afraid you'll have to be a little more specific. Can you point to where that is?

Q Yes.

(Pause.)

Q This is now, I believe, page 5 of -- oh, I seem to have made an embarrassing error. This is now in Mr. Rowsome's testimony on contention 1.1 and Board question 1.1. So maybe I'll reroute the question to Mr. Rowsome.

A (WITNESS ROWSOME) Page 5, you say?

Q Yes.

A (WITNESS ROWSOME) Okay, I'm there.

Q And there is a comparison, for example, of cancer fatalities expected within 50 miles as opposed to different kinds of fatalities expected from Indian Point in 50 miles.

A (WITNESS ROWSOME) Yes.

Q Is it true that, for example, early fatalities from Indian Point would be expected almost exclusively within say 15 miles of the plant, is it not?

A (WITNESS ROWSOME) Yes.

Q And cancer fatalities would be expected to occur with significantly higher frequency within 10 or 15 miles from the plant than they would at 35 or 40 or 45 miles from the plant, ›uld they not?

A (WITNESS ROWSOME) Somewhat higher. I wouldn't say so dramatically higher.

Q It is also true that the population around the plant is distributed in such a way that there are relatively few people within 10 miles from the plant as contrasted with 50 miles from the plant?

A (WITNESS ROWSOME) That is true.

Q So in drawing the comparison for 50 miles, you really tend to have the population in the range of 20 to 50 miles swamping the population within 10 miles, say; is that not correct?

A (WITNESS ROWSOME) In cancers I believe that is true.

Q So one might wind up with very different results if the comparison were drawn for 10 or 15 miles rather than 50 miles; is that correct?

A (WITNESS ROWSOME) Well, let me see. These were comparisons against background, and the comparisons against background are -- the population cancels out. You are comparing an individual's risk in one thing to an individual's risk in the other, so the population doesn't enter into that kind of a comparison.

Q Except that if we have one kind of comparison for the population within 10 miles and a very different comparison for those in the 30 to 50-mile range --

A (WITNESS ROWSOME) Well, as I indicated before, the function, the individual risk of fatal cancer from radiation exposure due to severe reactor accident declines only fairly gradually with distance. There is not a dramatic difference from 10 miles to 20 or 30 miles.

Q Would you also include out to 50 miles, including 30 to 50 miles?

A (WITNESS ROWSOME) Well, we can actually get the data from Dr. Archarya's tables where the individual risk versus distance is plotted and get the right answer, rather than guesstimating.

(Pause.)

A (WITNESS ROWSOME) I found one of the several graphs that portray this sort of thing, Figure III.C.26

in Dr. Archarya's testimony, "Individual Risk of Delayed Cancer Fatality Excluding Thyroid Per Site Year Versus" -- I gather "site year" means they added up the contribution from both Units 2 and Unit 3 -- "Versus Difference in the After-Fix Case."

We find a very steep decline in the individual risk of contracting cancer in the first few miles, but from about, oh, 5 miles on out to 50 miles there is a rather gradual decline with distance.

Q Thank you. So what you are saying in essence is that people living in all parts of New York City would face a risk of delayed cancer fairly similar to that of people living five miles from the plant?

A (WITNESS ROWSOME) Well, let's look it up. Let's draw one of your little level lines and we'll try to see what the difference is.

It looks to me as though it's a little over a decade, maybe a factor of 20 or so, and at say 50 miles there is -- an individual runs about, oh, 3 chances per billion per year of contracting fatal cancer from severe reactor accidents at the Indian Point site.

Q But given a factor of 20, if individuals in the 10 mile area are different from those in the 30 or 40 or 50-mile area by a factor of 20, and you then do a calculation where you do it just for the 50-mile area and 99.5 percent of the population in that 50-mile area is outside the 10-mile area, you don't get a very meaningful or accurate figure as far as those in the 10-mile area, do you?

A (WITNESS ROWSOME) Well, in fact, there are tables of societal risk versus difference in Dr. Archarya's results. So we can actually look at those numbers too, if you wish.

Q No, I don't think we have to.

JUDGE GLEASON: We really don't want to go back into the charts again, do we, Mr. Rowsome?

WITNESS ROWSOME: I don't think so.

JUDGE SHON: You know, Mr. Blum, what you seem to be asking is whether what I will call the percentage increase in chance of cancer above background cancers, is larger nearer the plant than away from it. And I think it is, isn't it?

WITNESS ROWSOME: Yes.

JUDGE SHON: And what you're saying is you think that integrating over 50 miles and then comparing it with a background rate over 50 miles gives you a smaller ratio than if you only do it over 10 miles.

That is probably true, isn't it?

WITNESS ROWSOME: Yes.

MR. BLUM: Well, that's all the point.

JUDGE SHON: Well then, why don't we go on.

MR. BLUM: Yes, I agree.

MR. BRANDENBURG: Unless Mr. Blum is interested in the shape of that curve, Judge Shon.

MR. BLUM: I think I'd like to ask, Mr. Rowsome, in another area now, about the omission of sabotage from PRA's, which is mentioned in his testimony.

BY MR. BLUM: (Resuming)

Q This omission -- did we cover this already in your earlier testimony?

(Laughter.)

Q All right, we'll go on to something else still.

In one piece of your testimony you make some statements about emergency planning, emergency response, emergency evacuation, do you not?

A (WITNESS ROWSOME) Yes, IV.D.

Q And it would be fair to say in general that you are somewhat less enthusiastic about this protective mode than some other people are?

A (WITNESS ROWSOME) I think that is a fair statement.

JUDGE GLEASON: What part of the testimony is that in?

WITNESS ROWSOME: Roman IV.D, the second of the four pieces of testimony before us at the moment.

JUDGE GLEASON: Which page?

WITNESS ROWSOME: I think he is making a general statement about the whole burden of that piece of testimony.

JUDGE GLEASON: Hold it.

JUDGE PARIS: Would you identify the piece of testimony again, please?

WITNESS ROWSOME: Unfortunately, I'm not sure it's title is unique, but up in the upper right-hand corner of the first sheet is a "IV.B" in parentheses.

JUDGE PARIS: That is the one?

WITNESS ROWSOME: That is the one.

BY MR. BLUM: (Resuming)

Q In general, you were then more enthusiastic about protective mitigative measures, such as filtered venting on the one hand than the mitigative measures in the Meyer and Pratt testimony; is that not correct?

A (WITNESS ROWSOME) I wouldn't have used the word "enthusiastic", no.

Q But you believe that those are likely to provide a greater measure of risk reduction?

A (WITNESS ROWSOME) I believe it is quite plausible that they do.

Q Do you recall discussing emergency response and emergency evacuation in your deposition?

A (WITNESS ROWSOME) I recall that I did.

Q It is true, is it not, that one of the grounds for your lack of enthusiasm for it is that you believe that there are some accident sequences which are quite catastrophic where evacuation won't work anyway?

A (WITNESS ROWSOME) I wouldn't have used the word "catastrophic", I don't think. But for the more severe releases characterized by very short times, characteristic times, such as what we have called release category A and B, evacuation will not reliably succeed in removing people prior to plume arrival.

Q And consequently, it won't succeed in protecting them from severe consequences of radiation exposure?

A (WITNESS ROWSOME) That is a little bit of a heavy statement, because I think it could be shown that under most weather conditions even release category A and B is fairly benign in its health effects.

Q If I could read in one question and answer from the deposition. This is the question: "Emergency response and emergency evacuation generally are unimportant because accidents either tend to be of the sort which are quite catastrophic, where evacuation won't work anyway, or they tend to be of the sort where there's no significant radiation, release of radiation, or there is such a long time to evacuate that anyone would be able to get out anyway. And since things are split among these three types of alternatives, there aren't many sequences where emergency evacuation is important, is that generally correct?"

And the answer was --

MS. MOORE: Mr. Chairman, I would object to reading questions and answers, unless this is being done for impeachment.

MR. BLUM: Well, they seem inconsistent, in that the witness said he would not use the word "catastrophic."

WITNESS ROWSOME: In fact, I did not. Those were their words and you're reading a question. And your final question was, is that not generally correct, and I think I probably answered in the affirmative at the time, not wishing to nitpick with you on the words.

MS. MOORE: Mr. Chairman, maybe it would be more helpful if the witness could see a copy of his deposition.

MR. BLUM: Certainly.

BY MR. BLUM: (Resuming)

Q Having this now, could you just read the answer to the question, "Is that generally correct?"

A (WITNESS ROWSOME) The answer I gave as reported here says: "With one exception it is correct, and the exception is that you cast it rather broadly to include all emergency response, which means a lot more than just evacuation. If you restrict it to anticipatory evacuation, that it is a fair summary."

I believe that is a correct transcription.

Q Thank you. And your views remain the same at the present time?

A (WITNESS ROWSOME) Yes.

Q There is one kind of theoretical problem I wanted to ask about with regard to uncertainty bands and PRA's, and perhaps both witnesses could address this. If you have a best estimate, say of 10^{-5}, and that is simply a best guess, but you really feel it could be as high as 10^{-3} or as low as 10^{-7}, given that band, if you look at it one way and you try to say -- well, first of all, given that band, you can't really assume, can you, that you have a normal distribution around the best estimate such that the probabilities are going to be very, very low at 10^{-3} and 10^{-7} both?

You just know that you're probably somewhere in the range of 10^{-3} and 10^{-7}; is that correct?

A (WITNESS ROWSOME) Are you making that as an assertion or as a hypothetical?

Q No, I'm asking your belief. Do you believe that you can assume?

A (WITNESS ROWSOME) That depends on the context. I can imagine occasions when you can assume it and imagine examples in which you could not.

Q Well, what would be some where you could not assume it?

A (WITNESS ROWSOME) Let's see, where would one get highly bimodal distributions? I am sure I have run across examples, but none come to mind at the moment.

Let us imagine a hypothetical situation in which you have a population of say pumps and some subset of a manufacturing run of pumps had a manufacturing flaw in it that led them to have very high failure rates and the others did not have that manufacturing flaw. We see this kind of thing with the recall of automobiles, for example. Every now and then a run of automobiles will have a flaw in it.

So the failure rates for that population could well be a bimodal distribution with a peak at both ends and a hollow in the middle. And to describe the failure rate distribution for that population with a normal distribution would be a misrepresentation of that case.

Q Well, where you have a very broad uncertainty and where you are not able to quantify, but you are able to make a statement that you're somewhat confident we are within a range of 10^{-3} to 10^{-7}, isn't this sort of -- and then you're going to reduce this to some sort of point estimate figure that you use, isn't there a somewhat subjective choice available to you as to whether you want to use 10^{-5}, because 5 is halfway between 3 and 7, or whether you want to go another approach and in a sense assign equal weights to 10^{-3}, $^{-4}$, $^{-5}$, $^{-6}$, and $^{-7}$. and sum those together and divide, which would then give you something much closer to, I guess it would probably be, between 10^{-3} and 10^{-4}?

A (WITNESS ROWSOME) There is an element of subjectivity to it. On the other hand, I don't mean to sound like Stan Kaplan here, but you may have a lot of additional information about the nature of the problem that leads you to be fairly objective in such judgments.

Q Right. But in situations where we have the very broad uncertainty bands, those tend to be ones where we don't have lots of additional information.

A (WITNESS ROWSOME) Not necessarily. You may very well know that the tails of the distribution arise from the freak coincidence of worst case here, worst case there, worst case somewhere else, and you know that that kind of compounding of improbable coincidences is itself extremely improbable. So you know that tail on the distribution really is pretty small. That is commonly the case.

Q Mr. Blond, did you want to add anything?

A (WITNESS BLOND) I would only add that, as Mr. Rowsome pointed out previously, the analysis that we have done or tried to do does have a bias of some nature, in that we do look for the most realistic assertion that we can get, but with a somewhat conservative bent, where we tried to stay on the higher side of things.

So the distribution in the way that Mr. Kaplan, or Dr. Kaplan, would describe it, there is a degree of knowledge as to where we are, so to speak, in that range of uncertainty.

Q So in the hypothetical that I posed about between 10^{-3} and 10^{-7}, would you in general be inclined to accept a figure somewhere between 10^{-3} and 10^{-4}, rather than the figure of 10^{-5}?

A (WITNESS BLOND) No. The estimate we were given in this case was 10^{-5}, I believe, which is what the analysis would have generated. Now you have put an error factor of 100 around that figure, and we would tend to say that that error factor might still stand, but our judgment would indicate that the 10^{-5} might be pessimistic, if anything. It might have overpredicted.

Q But what I am saying is, isn't there some real difference between 10^{-5}, give or take two orders of magnitude on either side, and 10^{-5} where we are very sure that it is within at least 3 -- you know, between 3 times 10^{-5} and a third times 10^{-5}? Aren't those, even though you would come up with 10^{-5} for both, aren't those numbers in some sense really very different entities?

A (WITNESS BLOND) The analysis has generated that number and the analysis has many calculations that are involved in it, obviously, and there is a judgment that you make as far as where you are in that distribution. Right now that factor of 100 is really a qualitative statement that you're making; it's not a quantitative statement.

We don't have, except in the PLG estimate, that quantitative assertion that here is the family of curves that we're really dealing with. If we had done that analysis to the rigor that they have done it or performed some other attempt, then we might be able to indicate what our level of knowledge or uncertainty is concerning that 10^{-5}.

Right now the only thing we might have to go with is, we would indicate that according to PLG our point estimate is a conservative point estimate to what the family of curves would indicate. This is the only attempt that we know that has been made to evaluate that.

Q But I take it in general you would agree that something is lost by not having a statement of the uncertainty range around the point estimate?

A (WITNESS ROWSOME) Yes.

MR. BLUM: We have no further questions.

JUDGE GLEASON: Mr. Hartzman?

MR. HARTZMAN: Yes, I just have a couple of questions, Your Honor.

CROSS-EXAMINATION ON BEHALF

OF INTERVENORS FOE AND AUDUBON

BY MR. HARTZMAN:

Q Earlier today in your cross-examination by Mr. Blum, you had occasion to make reference to the term "systems interactions," and I guess you expressed some reluctance to define that term. I wonder if you may perhaps help us with some sort of definition of how you would use the term "system interactions"?

A (WITNESS ROWSOME) Well, as I say, I try not to use it whenever I can avoid it. It has a formal meaning in the NRC because it has become an unresolved safety issue, a program to be dealt with, a safety issue to be dealt with in the agency. And there are a team of Staff members in NRR working on the resolution of this safety issue.

The safety issue itself has a formal definition which has been written down and I cannot reconstruct it from memory, and it would be inappropriate for me to try to guess it. The history of the issue is that the Advisory Committee on Reactor Safeguards some years ago registered a concern with the Staff that subtle ways that faults could propagate through the network of systems in nuclear power plants were perhaps not being studied well enough in the licensing process, and that perhaps there was a weak spot in our regulatory safety analysis that might need closing.

And they prodded the Staff to go out after it, and in fact the Staff is working.

Q Let me ask the question this way. There's testimony, previous testimony by Dr. Perrow, in which he spoke of accidents in which there could be multiple failures in independent units or subsystems which can interact in unforeseen and unexpected ways. Would that be what you could call a system interaction accident?

A (WITNESS ROWSOME) Perhaps, although as I say the word means so many different things to so many different people, I'm not sure you could get a consistent answer. If you had an array of witnesses here, you would get a wide array of answers.

Q Would Dr. Blond or would Mr. Blond have an opinion on that?

A (WITNESS BLOND) No, I really wouldn't.

Q It really has three or four different technical definitions by different parties, plus the bureaucratic definition that has grown up around the program, and it is kind of a messy concept. I'm sorry about that.

Q Are you familiar with Dr. Porrow's testimony in this proceeding?

A (WITNESS ROWSOME) I have read it. I think "familiarity" would be an overstatement.

Q Would the kinds of accidents that he described in his testimony, to the extent that you are familiar with the testimony, fall within this area of systems interaction problems that is being addressed by NRC Staff?

A (WITNESS ROWSOME) I must confess, I didn't find much coherence in that testimony and it would be hard for me to say.

MR. HARTZMAN: I have no further questions.

JUDGE GLEASON: Make it brief, Mr. Kaplan.

MR. KAPLAN: I'll be brief.

CROSS-EXAMINATION ON BEHALF
OF NEW YORK CITY COUNCIL

BY MR. KAPLAN:

Q Gentlemen, just to follow up on a point that Mr. Blum left, in terms of the completeness of the study I think there's just a couple of questions here of clarification. The Staff work in the IPPSS addressed a variety of uncertainties in order to quantify them. Among those uncertainties -- and we've talked about gaps and I don't want to get involved in that terminological war, but we've talked about areas that were not looked at.

Among those areas that are connected to the system of -- and I use "system" in a nontechnical term -- of the reactors, you see, it is a bounded, closed entity. Does either your study, the NRC Staff work, or the IPPSS address risks that may be developed out of the mining of uranium for commercial use?

A (WITNESS ROWSOME) No, we did not address the fuel cycle in our answer to Commission question one.

Q When you say you did not address the fuel cycle, what are the parts, what are the pieces in the fuel cycle?

JUDGE GLEASON: He said he did not address the fuel cycle.

MR. KAPLAN: Well, wanted to see if we could agree on a definition of what that fuel cycle is.

WITNESS ROWSOME: The fuel cycle runs from, as you suggest, the mining of uranium through the disposal of radioactive waste.

BY MR. KAPLAN: (Resuming)

Q So the points that were studied were the use of fuel to generate electricity, but what is not included in it would be the transportation of the fuel, the storage of the fuel after it is spent, and the disposition of the spent fuel, correct?

A (WITNESS ROWSOME) That is correct. The testimony under Commission question one, or for that matter question two, did not address anything other than reactor statement.

A (WITNESS BLOND) Excuse me one second.

(Pause.)

A (WITNESS ROWSOME) Roger points out that in the introduction we indicated that the risk posed by accidents at the site was dominated by literally reactor accidents. We didn't cavalierly dismiss, say, accidents in the spent fuel pool at the site. There is a literature to indicate the risk posed by accidents -- posed by the spent fuel pool is very small compared with that that we did deal with in depth. But we made no attempt to deal with risks associated with fuel before it arrives at the site or after rad waste is removed from the site.

Q I would use the word "failure", but I don't mean it in a pejorative sense. In that non-dealing with the issue, is it your position that there's no risk attendant with the mining, transportation, or ultimate disposition?

A (WITNESS ROWSOME) Only that it's out of scope for this Commission question.

Q Going to page 9, question 12, of the first piece of testimony, which on the original list was number 12 -- I haven't been able to grasp the new numbering. On the original list they distributed it was 12.

You made, I believe --

MS. MOORE: Mr. Chairman, might I clarify in case that creates some confusion? The list Mr. Kaplan is talking about is merely the cover letter that went with the testimony. It listed the items of testimony, and since there were so many numbers were put next to them, but they were in no way intended to correspond --

JUDGE PARIS: I lost that letter three days ago.

MR. KAPLAN: I have it noted down. It's the only way I can keep track of what's happening. This is the first piece of testimony. The other title is, I guess, "Direct Testimony of Mr. Blond and Mr. Rowsome, Summary Response to Commission Question Posed to the Board, IV.A., Conclusion." I think that is the right one.

WITNESS ROWSOME: I've got it, on page 9.

BY MR. KAPLAN: (Resuming)

Q On page 9, sir, where you made the correction this morning --

A (WITNESS ROWSOME) Yes.

Q -- where previously it read "for the most severe accidents", it now reads "for most of the severe".

A (WITNESS ROWSOME) Yes.

Q I would assume that, based on the correction, that there are accidents in which the probability that sufficient radiation could be released to cause potentially lethal exposure, but there are other accidents that would cause greater amounts; is that correct?

A (WITNESS ROWSOME) The most severe we analyzed and the most severe we found were called release category A. And you can find in -- I hate to give you another one of Dr. Archarya's tables, but you can find the consequence of that in Table III.C.5, but I haven't been able to find it.

Q I don't think you have to go look it up.

A (WITNESS ROWSOME) My understanding is that for that accident there is roughly even odds that no lethal doses will be delivered offsite and even odds that lethal doses will in fact be delivered offsite.

Q So when you say most, you are really talking about a 51-49 correlation?

A (WITNESS ROWSOME) Well, that is a very rare accident, and because of its extreme rarity compared with some of the others present in the risk profile on the plant, plays a very modest role in the overall risk profile.

Q Okay. Going to Page 14 of that same piece of testimony, Question 12, using -- I think you characterized it once before, the front paragraph is the one I am talking about --

A (WITNESS ROWSOME) I am with you.

Q That large paragraph, the second paragraph.

A (WITNESS ROWSOME) Yes.

Q It may not be as fat as the one you were talking about. Am I correct, what is going on there is a sort of cost benefit approach. Is that right? Would that be a mischaracterization?

A (WITNESS ROWSOME) Roger is the right one to answer.

A (WITNESS BLOND) That is fair. It is a sensitivity, but that would give you an indication of the benefits to the costs.

Q I realize that is a rough and ready way to look at it, more of a lay as opposed to a scientific approach. Let me ask a question then. As scientists and representatives of the staff, with that kind of cost benefit question, is that a question that should be made by scientists and people involved in the nitty-gritty, or are those really public policy questions that are sort of beyond the purview of the NRC staff approach to these questions?

A (WITNESS BLOND) As far as I am concerned, the reason we are showing them is to give an indication for the policy-maker what the option really is, at least in terms of the calculation that we would make. It in no way presumes to make a judgment as to what level would be warranted or desired.

JUDGE GLEASON: You can make anything safe if you want to spend enough money, Mr. Kaplan.

MR. KAPLAN: Thank you. I hope you are right. I am not sure.

WITNESS BLOND: We are really trying to get a perspective on that.

BY MR. KAPLAN: (Resuming)

Q Going to the next piece of testimony --

JUDGE PARIS: Do you know what that is, Mr. Kaplan?

MR. KAPLAN: That is 13. It is Direct Testimony of Mr. Rowsome and Mr. Blond Concerning

Commission Question 1. It is the one with the little IV.B up in the upper righthand corner.

BY MR. KAPLAN: (Resuming)

Q On Page 3 of that testimony, Question 9, this deals with the relationship between emergency response and risk. What historical data in the middle of the paragraph are we talking about? Is the only reference the evaluation cited, the EPA 520? Is there other historical data that you looked at to reach the conclusion that the historical data suggests there is no statistical difference between planned and unplanned evacuations?

A (WITNESS BLOND) The historical data is the document referenced.

Q That is the only one?

A (WITNESS BLOND) That is the one that is referenced.

A (WITNESS ROWSOME) That is the only formally published study that I know of.

Q And it is upon that document alone that in the last sentence that your confidence derives from?

A (WITNESS BLOND) That document as well as discussions with the authors about more recent information that they have been keeping track of that would not lead them to change their conclusion in a significant fashion.

Q On Page 8 of that testimony, following up on something that I think Mr. Blum did question you about, given the fact that you made a number of evaluations on the planning apparatus, I know Mr. Rowsome shared with us as part of -- or some of it, if, and this is in Question 14, regarding the fact that most of the latent cancer commitments originate from exposure that is greater than ten miles, do you have any opinion regarding the misapplication of planning and preparedness for sources for this particular problem, given the fact that planning and preparedness seem to be devoted for that area within the ten-mile zone but do not direct themselves with any resource application to the area beyond where, according to your judgments, most of the danger, at least from this cause, will be?

MS. MOORE: Mr. Chairman, I believe no foundation has been laid for that question. He hasn't asked these witnesses if they are familiar with the planning and preparedness at Indian Point. It is a very general question, and I would object to it on those grounds.

MR. KAPLAN: I would be glad to reframe it if the witnesses don't understand it.

JUDGE GLEASON: All right, rephrase it.

BY MR. KAPLAN: (Resuming)

Q In light of the statement made at the top of Page 8, and given, Mr. Rowsome, in particular, your judgments regarding the emergency planning that find their way into other parts of the testimony as currently under discussion, do you have an opinion regarding the application of planning and preparedness resources in light of the fact that most of those resources go into the ten-mile EPZ when at least in this instance, the fact that we are looking at, most of the consequences are beyond the ten-mile EPZ?

MS. MOORE: Mr. Chairman, I believe that is beyond the scope of the testimony, and I will object.

JUDGE GLEASON: Well, you know, it is and it isn't, because he is talking about emergency planning. Let him answer if he has an answer.

MR. SOHINKI: Mr. Chairman, I will object.

JUDGE GLEASON: All right. That is two of you. Do you want to object to the Power Authority -- You do want to object? All right. If you can't answer, just say you can't answer.

WITNESS BLOND: As a matter of fact, I do have an opinion. Having been one of the framers of the emergency planning zone concept when it was developed by the NRC, I have a definite opinion in terms of the difference between planning and response, and the concept of why the distance is chosen. It was a judgment that was made by a number of people in the task force where we considered many, many aspects of accident considerations as well as response considerations.

The principal reason that that number was chosen was from -- well, there were three main considerations. One was concerning relatively low doses for accidents which would be more presumed to occur with a greater frequency. These would not exceed protective action guide levels the EPA has suggested beyond ten miles.

A second one was for the very large accidents. You don't expect fatalities beyond about that distance, where an immediate response might be more desired.

The third was, given that you could plan within ten miles, it was felt by the experts who were involved in the task force that you could respond to any distance, there would be -- no, that ten miles is in no way a reflection of the response that would be required during an emergency. We tried to make it very clear in the documents that we published that the ten miles has nothing at all to do with response, that given an accident, the intent is that you would have a dynamic situation at hand in which you have to measure and judge the response that will be required, and that planning will give you the ability to do that, no matter what distance you've got.

MR. BLUM: Your Honor, I think I would join in the objection to Mr. Brandenburg continuing in this area, or Mr. Kaplan. I am sorry.

JUDGE GLEASON: All right. That is three. I don't know where he is going. Go ahead.

BY MR. KAPLAN: (Resuming)

Q I just have one more question. Then, if I can follow up, Mr. Blond, the concept is that in fact, though there might be, if you will, an evacuation within ten miles despite the question of the effectiveness of our capability to do that, the planning process conceives of mobilizing our resources far beyond those ten miles in terms of a response capability and utilization of resources beyond the ten miles. Is that fair from what you have just said?

MS. MOORE: Objection.

JUDGE GLEASON: Objection granted. You are way off the beam now.

MR. KAPLAN: I was following the previous answer.

JUDGE GLEASON: You are pushing the limit.

MR. KAPLAN: I have no further questions.

JUDGE GLEASON: Any questions on the part of the licensees?

MR. BRANDENBURG: Yes. Con Edison has questions, Mr. Chairman.

JUDGE GLEASON: Proceed.

WITNESS ROWSOME: If I may, I would like to request a rest break pretty soon.

JUDGE GLEASON: All right. Let's take a five-minute break.

MR. BRANDENBURG: Mr. Chairman, it is 12:30.

JUDGE GLEASON: No, we are going to make an effort to wind up this testimony, Mr. Brandenburg.

(Whereupon, a brief recess was taken.)

JUDGE GLEASON: Mr. Brandenburg, we would appreciate it if you could, if possible, cover your cross examination in an hour.

MR. BRANDENBURG: I don't think I will disappoint you, Mr. Chairman.

JUDGE GLEASON: Then I should say a half hour?

MR. BRANDENBURG: I will accept your original offer.

JUDGE GLEASON: A number of people do have commitments, and that is what I am saying to you. It involves plane travel. And we still have to hear from Dr. DuPont.

CROSS EXAMINATION ON BEHALF OF
CONSOLIDATED EDISON

BY MR. BRANDENBURG:

Q Mr. Rowsome, Mr. Blum asked you a number of questions on his cross examination of plant to plant and PRA to PRA comparisons in the area of source terms, and I just wanted to ask you one or two questions on that.

My first question relates to one of Dr. Acharya's answers. You referred to his testimony yourself a number of times. It is Question 10 and Answer 10 that appears on III.C.A-5 of his testimony.

A (WITNESS ROWSOME) Yes, I have it.

Q Now, in the question Dr. Acharya is asked what plant specific inputs to the CRAC code are required, and he goes on to describe the ones that were employed in connection with the staff's testimony in this proceeding, and he mentions the fractions of core inventory of radio nuclides and so on.

I was intrigued by the adjective of plant specific, however, in the question, and I am wondering if you can tell us what plant specific aspects should be considered when one is attempting to determine source term inputs to a PRA calculation.

MS. MOORE: Objection, Mr. Chairman. This is not Mr. Rowsome's testimony. This is Dr. Acharya's testimony.

JUDGE GLEASON: I think that has to be granted, Mr. Brandenburg.

BY MR. BRANDENBURG: (Resuming)

Q Well, without reference to Dr. Acharya's testimony, you responded, I believe, to Mr. Blum's questions that plant to plant and PRA to PRA comparisons would have a certain flavoring from your perspective because of similarities and non-similarities of source term assumptions. My question to you is, in connection with your position on that point, what plant specific features you think should be considered that would affect the comparability of PRA's to PRA's and plants to plants.

MS. MOORE: Mr. Chairman, I believe the witness testified that the source term was not an issue in plant to plant.

MR. BRANDENBURG: That is what I am probing.

JUDGE GLEASON: That is what he is trying to find out. Let him respond.

MR. BLUM: This one question is okay, but I would like to note that I raised the matter of uncertainties relating to the area which includes source term, and was referred that the specifics of this should be dealt with in the Meyer and Pratt testimony.

JUDGE GLEASON: He may say the same thing. I am not trying to suggest an answer.

WITNESS ROWSOME: I was intending to say that Dr. Meyer is the appropriate one to answer that question. I can give, perhaps, a kind of framing answer to it. It would be useful in making plant to plant comparisons to have comparable assumptions on the source term. If one does not have comparable assumptions on the source term, one has to compensate in some fashion or take into account that in calculating ratios of risks, for example, the ratio may be an artifact of differences in premises rather than differences in the plants.

As to what plant specific information one needs to do source terms, that is a function of one's approach to source terms. We have three represented here in testimony either by the staff or by the licensees. The staff adopted what is essentially WASH-1400 source terms with the modest improvements in the CORRAL code that have been made since WASH-1400 days.

The licensees in doing the original IPPSS dealt with alterations in the source term through the U factor, and you have presented testimony of still another approach here. They are quite different approaches. They do not necessarily yield consistent or comparable results.

BY MR. BRANDENBURG: (Resuming)

Q Mr. Rowsome, based upon your experience with probabilistic risk assessments, would you consider such features as the configuration of the reactor cavity, the volume of containment, and the configuration of the upper plenum of the reactor as significant considerations in attempting to model radio nuclide behavior?

MR. BLUM: Objection.

MS. MOORE: Objection. It is outside --

JUDGE GLEASON: That really is outside the scope of his testimony, Mr. Brandenburg.

BY MR. BRANDENBURG: (Resuming)

Q Mr. Rowsome, I would like to ask you a question about Figure IV.A.1 that appears in your testimony and that of Mr. Blond under the rubrick of IV.A.

A (WITNESS ROWSOME) We each have it in front of us.

Q Now, I was interested in -- there are four bar graphs appearing on this page. I was interested in the caption for the top two representations, "Before Denton Fixes" and on the latter two the "After Denton Fixes." Could we start out by telling us what you understand the exact fixes that we are talking about here?

A (WITNESS ROWSOME) Yes. I am glad you have given us a forum to explain something that may be confusing to the Board, and that is that the differences between the staff analysis of -- it would be after fix case and the after fix case to which your witnesses have testified here -- is quite different. What they have in common is that both the licensees' testimony here and our testimony credits alterations in the ceiling of the control building of Unit 2 to reduce its fragility, in particular to reduce the potential for structural damage to the control building from the bumping of the Unit 2 control building into the Unit 1 superheater building.

Second, both the licensees' testimony and the staff testimony credits the interim fire fixes made in the direction of but not constituting complete compliance with Appendix R in both Units 2 and 3. There, the two after fix conceptions, ours and the licensees', part company.

We credit one additional fix, that being the technical specification mandating anticipatory shutdowns for hurricanes at Unit 2, but as I understand the testimony I heard last week, that is not in the licensees' current analysis.

In addition, the licensees' current analysis, again, as I understand what I heard a week ago, includes a number of other things that are not in our after fix case. To wit, the modifications of the control room ceiling and the recalculation of the fragility of the containment structure itself.

Q All right.

To save time, Mr. Rowsome, would this after fix and before fix rubrick in the staff's testimony appear generally throughout? We are not just confined here to Figure IV.A.1, are we? Is this not a uniform interpretation?

A (WITNESS ROWSOME) That is correct.

Q Now, I would next like to ask you about the use of the word "Denton" fix, and I am inferring from that that Mr. Denton is willing to either take the credit or the blame, as the case may be, in initiating those, but in fact that is not the case, is it?

Can you explain to us your knowledge of how the fixes that are modeled in the staff's testimony came about, if you know?

A (WITNESS ROWSOME) Yes. The NRR decided last fall to use some arm-twisting or jaw-boning, if you will, to encourage the four fixes, the two fire fixes in the two units, the hurricane and tech spec, and the seismic fragility Unit 2 control not sealing with the roof of the Unit 2 control building; decided to press Con Ed and PASNY to make those changes.

It is my understanding that Con Ed was already preparing to make two of those changes spontaneously, and that not much arm-twisting, if any, was needed.

Q Now, with respect to not the sealing fix, but the fix that you referred to was the interaction between the Unit 1 and the Unit 2 control room walls, I believe, is it your understanding that the seismic susceptibility of the Unit No. 2 to a seismic event from this interaction was first identified in IPPSS?

A (WITNESS ROWSOME) Yes.

Q And do you have any knowledge as to whether or not the so-called fix to that interaction, the insertion of the absorption material, was first proposed by the Licensees to the Staff?

A (WITNESS ROWSOME) It is my understanding that it was proposed by the Licensees.

Q Now, with respect to the so-called fire fix, which I believe you made a correction in your testimony this morning, it's your testimony that that fix has been implemented at Unit No. 2 and it is being implemented in Unit No. 3. Is it your understanding that those modifications to the plants or the original inspiration for doing those came from the Licensees?

A (WITNESS ROWSOME) That is correct. Well, let's say -- inspiration, I'm not sure I want to buy that. I think that the Licensee proposed the design, and it's my understanding that the Licensee had already initiated that effort before NRR brought it up. On the other hand, NRR I think brought up -- did bring up the issue in their first communication on the subject.

Q Would you consider it as fairly within your testimony -- and I guess I'm mainly referring you to your IV.C testimony, which is perhaps the most philosophical of your various pieces -- would you consider within the scope of that testimony an evaluation of the use of PRA by plant operators as a risk management device or as a tool to further reduce risk, or do you consider that one outside the scope of that piece of testimony?

A (WITNESS ROWSOME) I don't remember whether I made mention of it in that testimony or not, but I expect to make more mention of it in Commission question 5 testimony.

Q Well, perhaps we'll defer that. Thank you.

While we are on testimony IV.B, I had a question about answer 9 on page 3 that follows up to one that Mr. Kaplan asked you. And he asked you about --

A (WITNESS ROWSOME) Excuse me. Which section of testimony?

Q This is IV.B, the testimony of you and Mr. Blond on question one, answer 9 on page 3.

A (WITNESS ROWSOME) I have it.

Q Now, as I understood Mr. Kaplan's line of questioning, he asked whether the Hans and Sell reference was the sole basis for the conclusion that you reach about planned versus unplanned evacuations. Mr. Rowsome, let me ask you personally -- let me ask you first, are you familiar with the Hans and Sell document referred to here?

A (WITNESS ROWSOME) I read it some time ago. I don't remember it.

Q Mr. Blond, are you familiar with the Hans and Sell materials?

A (WITNESS BLOND) Yes, I am.

Q Is it your general feeling that Messrs. Hans and Sell in this document reviewed a number of historical evaluations prior to reaching the conclusion that you reflect here?

A (WITNESS BLOND) That is my understanding, yes.

Q Do either of you recall the approximate number of evacuations or the period of time or some other reference to the fairness of the Hans and Sell research?

MR. BLUM: Objection. We are now going into questions 3 and 4 on emergency evacuation and so forth, the same thing that Mr. Kaplan was cut off.

JUDGE GLEASON: Objection is denied. Answer the question.

WITNESS BLOND: I do have the report with me, but I don't recall.

WITNESS ROWSOME: My recollection is that there were several hundred, counting the minor ones, and a number like 50 for the more substantial ones, involving a large number of people moved.

BY MR. BRANDENBURG: (Resuming)

Q Mr. Rowsome, I did want to ask you a few questions next about your piece IV.C, on the accuracy of risk assessments.

JUDGE PARIS: About what, Mr. Brandenburg?

MR. BRANDENBURG: It is the direct testimony of Frank H. Rowsome concerning IV.C, accuracy of risk assessments.

JUDGE PARIS: While you are looking that up, I would like to ask a question just to make sure something is clear. The Denton fixes referred to in figure IV.A.1 are fixes ordered by NRR in 1982, is that right?

WITNESS ROWSOME: They were not ordered, but they were encouraged by NRR and credited in their analysis. The time of implementation has been this fall and this winter. And as pointed out in the corrected testimony on Unit 3, they are ongoing now, as I understand it.

JUDGE PARIS: Okay. Since Commission question 2 refers to some fixes ordered by the Director back in 1980, I wanted to make sure when it said "Denton fixes" here we were clear what we were talking about.

WITNESS ROWSOME: That's right.

JUDGE GLEASON: Mr. Brandenburg?

MR. BRANDENBURG: That might be a good follow-up, Judge Paris.

BY MR. BRANDENBURG: (Resuming)

Q Then all the before-fix, after-fix differentiation made in the question one testimony in which you participated, Mr. Rowsome, in each such instance are the so-called "fixes" that were referenced in the Director's order of February 10, 1980 excluded? I think that is where Judge Paris is going. Are we clear on that? The fixes here?

A (WITNESS ROWSOME) To my knowledge, to my knowledge there's no reference to the Director's orders of February 1980 anywhere in Commission question one testimony.

Q Now, I don't have a particular passage here, Mr. Rowsome, but throughout your IV.C piece you discuss generally the implications of PRA modeling on completeness, on certainty, accuracy of results, and so forth. Then later at pages 7 and 8 of your testimony you discuss the effects of omissions on the accuracy of the risk projected.

A (WITNESS ROWSOME) Yes.

Q I think you go on to explain why in your view it is unlikely that the IPPSS could have understated the risk significantly, but I'd like to ask you about any omissions or inaccuracies or modeling simplifications or what have you in IPPSS that you are aware of that might have resulted in overstatement in the risk. And the first such instance I'd like to ask you about is the failure of IPPSS to model recovery actions by plant personnel that would occur after the onset of core damage but prior to a breach of containment and a resultant release.

Is it indeed your understanding that no such recovery actions were modeled in IPPSS? Once the fan coolers were assumed to be lost and core damage started, that they were presumed to stay lost, for example, things of that sort? Is that your understanding?

A (WITNESS ROWSOME) With the possible exception of AC power restoration, that is my understanding.

Q Now, in the IPPSS 2RW late overpressurization release, do you recall that the modeling presumed a time period of 13 hours between the initiating event and the release; is that correct?

A (WITNESS ROWSOME) Yes.

Q And in the Staff's release category C events, 12 hours was assumed to elapse between the occurrence of the initiating event and the resultant offsite release; is that right?

A (WITNESS ROWSOME) 13 hours, I believe.

Q 13. Do you think recovery actions such as efforts to get the fan coolers working again or get the sprays going again and other types of equipment, getting water into the containment, things of that sort, would likely be undertaken during this 12 to 12-hour period if an honest-to-goodness 2RW or release category C event was to actually take place?

A (WITNESS ROWSOME) Yes, very probably.

Q And these, I think we agree, were not modeled in IPPSS?

A (WITNESS ROWSOME) Other than insofar as they entailed loss of offsite power and failure of the diesels and the like, recovery there was modeled very carefully. But for the fire or seismic-induced sequences, I do not recall credit for recovery or repai before the point of no return for saving the containment.

Q Would you think that, had efforts been made to model the recovery of safety devices such as fan coolers and sprays, that it is likely that the results of such sequences as modeled in IPPSS would have shown a reduction in risk? In other words, do you think some of these modeling omissions are likely to be significant in your judgment in terms of the presentation of results?

A (WITNESS ROWSOME) Not large compared with the uncertainties professed.

Q Are there other modeling simplifications or inaccuracies or things of that nature that you or anyone else on the Staff identified in the course of their review of IPPSS which you believe might have resulted in an overstatement of the risk in the IPPSS results?

A (WITNESS ROWSOME) Several have been identified in the testimony or in the Sandia NUREG report, CR-2934.

Q I am seeking your impressions and conclusions regarding these at this time. Could you just tell us briefly what modeling simplifications and inaccuracies or the like in your judgment, after having considered all this material, you have concluded may have resulted in an overstatement of the risk in the IPPSS?

A (WITNESS ROWSOME) Well, one or two come to mind. The assumption that the damage states TE and SE invariably lead to overpressure failure I think is a conservatism. I'm sure there are others, but they don't come to mind at the moment.

MR. BRANDENBURG: Mr. Chairman, I'm delighted to tell you that I have completed my cross-examination. I point out, it's well within the time limit that you had anticipated.

JUDGE GLEASON: My congratulations, Mr. Brandenburg.

Mr. Colarulli?

MR. COLARULLI: Your Honor, I have one question that basically seeks a clarification.

CROSS-EXAMINATION ON

BEHALF OF LICENSEE PASNY

BY MR. COLARULLI:

Q Dr. Rowsome or Dr. Blond, in your testimony on IV.B, could you turn to page 10. On page 10, Table

IV.B.3 is presented. The first item on that table reads "Seismic Direct Containment Backfill Failure, Unit 2." And then if you go down to the seventh item, it say "Seismic Direct Containment Backfill Failure, Unit 3." Now, as I understand it there was no backfill used at Unit 3, as Unit 2. So I'm just confused as to the significance of this and what it is that you were attempting to estimate.

A (WITNESS ROWSOME) My recollection from the site visit is there was some backfill, but it's much lower at Unit 3 than at Unit 2. It's not like up to the ramp, the vehicle ramp.

Q Could you give us a sense of the backfill you think is at Unit 3 as opposed to at Unit 2?

A (WITNESS ROWSOME) I don't remember. I do remember it was substantially less, and in fact the seismic calculations do indicate that the seismic fragility at Unit 3 is a good deal less than Unit 2, and that seems to be a reflection of that.

Q And specifically, where do you think the backfill is at Unit 3?

A (WITNESS ROWSOME) I don't think any particular significance should be attached to that parenthetical phrase. If you would like it deleted, I'd be happy to delete it for you. I don't think it makes any difference.

These are our assessments of the seismic fragility at Unit 3. My understanding was the IPPSS attributed the dominant seismic failure mode to shifting soil bumping against the side of containment. Whether it is literally backfill or not, I don't know, and whether that is literally the dominant seismic vulnerability of Unit 3 or not, I don't know. So I was perhaps a little presumptuous in putting the parenthetical phrase on Unit 3 as well as the Unit 2 contributor.

MR. COLARULLI: No further questions.

JUDGE PARIS: Mr. Rowsome, do you know of any estimates in IPPSS which you think are understated?

WITNESS ROWSOME: Yes.

JUDGE PARIS: Could you tell me what those are?

WITNESS ROWSOME: Well, there are a number of instances documented in NUREG/CR-2934 where they came up with higher frequencies for accident sequences.

JUDGE PARIS: Well, you need not go through those.

WITNESS ROWSOME: I'm not aware of any that don't appear in the testimony or in the NUREG reports we have brought along as part of the testimony.

In the containment analysis area, I believe Dr. Meyer indicated in his testimony, that you have not head yet, that he believes the Licensees underestimated the amount of hydrogen that could be released. But he'll be a better witness on that.

JUDGE PARIS: We'll wait and hear that from Dr. Meyer.

I just wanted to wait and get your impression about IPPSS and the reliability estimates in it. I take it, except for those that have been documented in the testimony or in the exhibits, you have no other major reservations?

WITNESS ROWSOME: That is true. I think it was an honest and largely unbiased attempt by the Licensees to portray their most realistic, most unbiased, most central estimate of the risk. We have found instances where we feel justified in stripping away some of the conservatism they used, and there are places where we feel a little more conservatism was warranted.

Altogether, our risk projections come out somewhat higher than theirs do. But we have employed a somewhat larger measure of conservatism in our analyses than they, and ultimately, if the objective is optimum realism, I cannot say which is the better study. If the objective is a fairly secure foundation for regulatory decisionmaking, I prefer ours.

JUDGE PARIS: Thank you.

Mr. Blond, do you have anything to add to the comments he's made?

WITNESS BLOND: No. I would basically concur with what Mr. Rowsome has indicated. I really don't have anything specific that I can point to in terms of conservatisms or nonconservatisms of the analysis, other than what we have indicated previously.

JUDGE PARIS: Would you prefer theirs or yours?

MR. COLARULLI: Is this off the record?

WITNESS BLOND: I think I'll let Mr. Rowsome's statement stand.

JUDGE PARIS: Thank you.

JUDGE GLEASON: Any redirect, Ms. Moore?

MS. MOORE: I have no redirect.

JUDGE GLEASON: Ms. Moore, do you recall -- I'm just trying to perhaps tie a loose end here together, which may not be a loose end -- sending a letter with respect to some questions the Board had with respect to -- I'm not sure -- it was the filtered vented containment system under Board question 2, which were supposed to be answered by one of your witnesses, and one -- I had your letter and I misplaced it.

MS. MOORE: I believe that was taken care of. If you're referring to the same letter I think you are, it is a letter that was submitted when we thought there might be some confusion created in the record about the Meyers testimony under question 2. And the clarification was made when we submitted Dr. Meyer for the introduction of his testimony into evidence, just before the motion to strike was discussed.

JUDGE GLEASON: All right. But if there's any question on this, if they're still remaining, it can be directed at Dr. Meyer if and when he comes back to the Board.

MS. MOORE: Yes.

JUDGE GLEASON: Gentlemen, you are excused. Thank you very much for your testimony.

(Witnesses excused.)

JUDGE GLEASON: That concludes the testimony, except for Mr. Meyer and Mr. Pratt, I guess, on question one.

MR. COLARULLI: Your Honor, the Power Authority calls Dr. Robert Dupont to the stand.

(Witness sworn.)

Whereupon,

ROBERT L. DUPONT, M.D.,

called as a witness by counsel for Licensee PASNY, having first been duly sworn by the Chairman, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. COLARULLI:

Q Dr. Dupont, could you please state your full name and business address?

A (WITNESS DUPONT) Robert L. Dupont, M.D., 6191 Executive Boulevard, Rockville, Maryland, 20852.

Q And what is your present position?

A (WITNESS DUPONT) I am clinical professor of psychiatry at Georgetown University Medical School, a clinical associate professor, visiting professor, at Harvard Medical School, President of the Phobia Society of America, and am in the private practice of psychiatry.

Q Do you have before you a copy of a document entitled "Power Authority Testimony of Robert L. Dupont, M.D., on Commission Question One"?

A (WITNESS DUPONT) I do.

Q And was this document either prepared by you or under your direct supervision?

A (WITNESS DUPONT) It was.

Q Do you have any changes or corrections to that testimony?

A (WITNESS DUPONT) Three minor corrections, Mr. Colarulli. Page 1, Line 13 --

Q Dr. DuPont, are these included on the errata sheet?

A (WITNESS DUPONT) Yes, we can just submit those.

Q Are there any other additions?

A (WITNESS DUPONT) No, there are not.

Q Dr. DuPont, is this testimony accurate and true to the best of your information, knowledge, and belief?

A (WITNESS DUPONT) It is.

Q And do you adopt this document as your testimony in this proceeding?

A (WITNESS DUPONT) I do.

MR. COLARULLI: Your Honor, the Power Authority moves that the testimony entitled Power Authority's Testimony of Robert L. DuPont, M.D., on Commission Question 1 be admitted into evidence and bound into the record as if read.

JUDGE GLEASON: Well, you understand we are admitting this on III.2, not on Commission Question 1.

MR. COLARULLI: Yes, we will modify the title to say Contention III.2.

JUDGE GLEASON: Is there objection?

(No response.)

JUDGE GLEASON: The Board hearing none, the testimony will be received into evidence and bound into the record as if read.

(The prepared testimony of Dr. DuPont follows.)

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
James P. Gleason, Chairman
Frederick J. Shon
Dr. Oscar H. Paris

In the Matter of CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. (Indian Point, Unit No. 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit No. 3)	Docket Nos. 50-247 SP 50-286 SP January 24, 1983

POWER AUTHORITY'S TESTIMONY OF
ROBERT L. DuPONT, M.D.,
ON ~~COMMISSION QUESTION 1~~
Contention III.2

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POWER AUTHORITY'S TESTIMONY OF ROBERT L. DuPONT, M.D., ON QUESTION 1: RISK OF NUCLEAR POWER IN PERSPECTIVE

My name is Robert L. DuPont. I am a Clinical Professor of Psychiatry at Georgetown University Medical School, President of the Phobia Society of America, Inc., President of the Institute for Behavior and Health, Inc., and from 1973-1978 was the Director of the National Institute on Drug Abuse. In 1978, 1979, and 1980, I chaired Special Sessions on the "Treatment of Phobias" at annual meetings of the American Psychiatric Association. In 1979, I was asked by the non-profit Media Institute to review network television news coverage of nuclear power between 1968 and 1979. This led to publication of "Nuclear Phobia -- Phobic Thinking About Nuclear Power." In October 1981, I participated in an international conference at Ditckley Par, England, on the media coverage of nuclear power. A statement of my professional qualifications is attached.

I. Introduction

This testimony addresses Commission Question 1, which states:

> What risk may be posed by serious accidents at Indian Point 2 and 3, including accidents not considered in the plants' design basis, pending and after any improvements described in (2) and (4) below?[1]

1. Memorandum and Order, Appendix at 1 (Nov. 15, 1982) (the

The evaluation of the risks of Indian Point should be based not only upon quantitative analysis, but also upon an examination of the risk perceived by some residents of the area surrounding the plants. This testimony presents a qualitative analysis of the bases for this perception. A complete understanding of these bases adds a useful perspective for decisionmaking on issues of risk in this proceeding.

For over 25 years, nuclear power has been used to produce electricity in the United States. There are now 73 nuclear power plants producing about 12.5 percent of the electricity in this country (Ref. 1). Nuclear power is also an important producer of electricity around the world, with a total of almost 200 nuclear plants operating in 22 countries on five continents (Ref. 2).

While the electricity produced by nuclear power plants is no different from that produced by coal, oil, or hydroelectric plants, there is one product of nuclear power plants which is different: fear.

This widespread public fear exists despite the fact that during these 25 years of commercial nuclear generation of electricity, no member of the public and no nuclear worker has been killed as a result of a radiation or other "nuclear" accident anywhere in the United States. This is a

full text of Question 1 is not reproduced here).

paradox which bedevils nuclear power: a crippling public fear in the face of verifiable evidence of an excellent safety record. This paradox is especially striking considering the fact that many people fear a means of generating power -- nuclear -- and yet do not fear the product -- electricity. This is despite the fact that in 1981, in upstate New York alone, 25 people were electrocuted (Ref. 3).

While I will not review the evidence of the safety of nuclear power as it has actually operated -- including accidents such as the costly and well-studied one at Three Mile Island in 1979 -- I will examine the paradox of fear in the presence of relative safety, because I am convinced, after three years of study of this specific problem, that the paradox can be explained on the basis of accepted psychological principles. I will also relate the operation of these basic psychological principles to the political opposition to nuclear power and sketch some ways in which this unrealistic fear of nuclear power could be reduced.

II. The Nature of the Fear of Nuclear Power

The most striking aspect of the fear of nuclear power is the contrast between the perceived risk on the one hand and the actual safety record on the other hand. Because both the fear and the safety record are well-known, how is it possible that the public did not long ago correct its misperception? To answer this question, one must know more about fear, especially the irrational aspects of fear.

For the last five years, I have specialized in studying phobic thinking and in treating people with phobic fears. These fears are often severely crippling and are resistant to rational arguments. These phobic fears include fears of bridges, tunnels, elevators, and airplanes. In most cases, there is some danger (bridges do collapse, elevators do get stuck, planes do crash), but the risks in these everyday settings are so low that most of us accept them as a matter of course. Not the phobic person. For the phobic person, the recitation of the actual safety record of bridges or airplanes is not reassuring.

I want to make it clear that these people with phobic fears do not have a mental illness in the sense that they are not psychotic, "disturbed," or "crazy." Rather, they are normal people who have an exaggerated and specific fear that is out of proportion to the actual danger or risk that exists. They "think phobically" about things that either do not frighten most people or merely make the prudent person nervous. For example, many people are nervous when taking an airplane flight. The phobic person is so frightened of flying, despite the excellent safety record of the airline industry, that he will not fly. The prudent person will not put his hand in a snake's mouth. The phobic person will not cross a field because there could be a snake in the grass, the snake could be poisonous, and he could be bitten by the snake. Additionally, we cannot guarantee the phobic person that this will not happen.

Phobic thinking can thus be disruptive, even crippling, in someone's life. This kind of thinking can override the phobic person's ability to make balanced, prudent assessments of the actual risks in his life. It is my experience that when a person thinks phobically, this thinking stands in marked contrast to the sensible, rational manner in which such a person typically makes other decisions in his life.

The chief characteristic of these "phobias" is "what if" thinking rather than "what is" thinking. For example, can I, as a psychiatrist, tell my patient who fears getting on an airplane that it is totally certain that HIS plane will not crash? No, I cannot. He can always say, "But it could crash," and he is right. If no airplane crashed for the next 50 years, the phobic ("what if") argument still holds because it is not based on actual experience, but on what could happen. Even with 50 years of complete safety in the air, the fearful non-flyer cannot be completely reassured: the one plane he steps onto might crash. Actual experience is not reassuring to many fearful people. They shift the argument from "what is" (or what has been) to "what if" (or what might be). Once that shift has taken place, rational arguments are irrelevant because the source of the fear is the fearful person's own inner terrors, not the actual risk to physical safety.

While I am drawing on my clinical experience with phobic people in considering the fear of nuclear power, I do not think that all people who either fear or oppose nuclear power are phobic. Understanding phobic thinking, however, provides a helpful basis for explaining why some people fear nuclear power. Such people are very afraid of nuclear power (a "what if" risk) and yet, without fear, travel in their cars (a "what is" risk) to protest it. The fear they feel is out of proportion to the actual risks, which are in many cases known to these people. This is phobic thinking. Understanding the widespread fear of nuclear power is made easier by recognizing the analogy of phobic fear.

There is another, related paradox in the fearful avoidance routinely seen in the behavior of phobic people: their fear is less the fear of physical danger (such as the fear that the elevator may get stuck or that the airplane may crash) than it is the fear of the feelings the fearful person experiences when exposed to the fear-provoking stimulus (the elevator or the airplane, for example), or even the thought of this stimulus. Thus, while the phobic person may be convinced that the frequency of the elevator getting stuck or the airplane crashing is low, the frequency of the fearful feeling is high. Every time the phobic person confronts or thinks about his phobic stimulus, he feels great distress, even if he is in no actual danger. Thus, the underlying threat is often less the threat of physical harm than the threat of painful feelings. These feelings can sometimes be so severe that they are called "phobic panic."

Although those who fear airplanes are often poorly informed about the scientific facts of airline safety (including such issues as design, manufacture, maintenance, and operation of the airplanes, as well as management and regulatory controls), these facts are available and are sometimes brought into the argument (as was the case when a DC10 crashed in Chicago three years ago and much sophisticated discussion went into supporting the fear of flying on that particular plane). In the nuclear power debate, the existence of a political opposition to nuclear power, an opposition which is often technically sophisticated, makes it appear that the risk of nuclear power is greater than we rationally know it to be. That is, these opponents can often discuss the mechanics of nuclear reactors and their possible accidents in a technically competent manner. This does not mean, however, that such accidents are likely to happen.

In any event, whether the fearful person fears airplanes or nuclear power plants, and whether he is technically sophisticated or not, the central argument holds: as long as the discussion of health hazard is restricted to actual experience (and not to "what if" thinking), then the paradox I am exploring is unmistakable because fear is widespread despite an excellent safety record.

It is essential to our understanding of the fear of nuclear power to recognize that the problem the fearful person has, in the end, is not the external stimuli associated with the fear -- it is not the airplane or the bridge or the nuclear power plant. Although the fearful person knows that the situation he fears is highly unlikely, the fear can be so intense as to seem unbearable. This is the problem. This is critical to understanding both prevention of fear and treatment of phobias: to overcome a phobia, the phobic person needs to recognize that the fundamental problem is inside himself and not in his environment. It is not possible to entirely solve the problem of fear of airplanes by avoiding airplanes, by promoting a greater understanding of how airplanes work or by enforcing more stringent regulation on the airlines. The fearful person will still be afraid of airplanes because the "what if" thinking will still exist. The plane could still crash. (Planes can even crash and kill people on the ground -- at least 12 people were killed in this manner in 1982 (Ref. 4). Yet, despite this "what is" danger, few people who fear nuclear power scan the sky to see if a plane is about to fall on them.)

That the problem of the fearful person is inside himself is illustrated by the fact that phobic people often report that they spend hours every day worrying about an event they know to be unlikely. They especially worry about how they will act in a situation they fear. I have spoken to many people who are afraid to fly. They tell me that they are afraid they will panic on an airplane, that they will lose control of themselves, perhaps faint, scream or in some ill-defined way simply "go berserk." They know that airplanes do not crash very frequently. They are afraid of their own fear.

Similarly, people who are inordinately fearful of nuclear power are often afraid of how they, or people like themselves, will react should a nuclear accident occur. They fear that people who are sensible and responsible, as they are, will behave in a senseless and irresponsible manner.

Such fears are groundless. For example, when airplane phobics are able to actually take a flight on a plane, none has panicked. While there has never been a nuclear accident requiring prompt public action, I am convinced that fears that people will behave callously or irresponsibly are just that: fears only. Experience has taught us that, when dealing with emergencies, people behave competently, responsibly, and sensibly.

In fact, in an actual emergency, when even the phobic person must face his fear to ensure his own personal safety or to help another person in distress, the phobic person, unlike the psychotically disturbed person, will behave rationally and effectively. It is a commonplace observation in the treatment of phobic people that they will, in a crisis, do what needs to be done, even if that means temporarily overcoming their fear. The mother who does not drive because of a phobia will not hesitate to drive an injured child to a hospital.

In real-life emergencies, phobic people do not panic or behave irrationally. Their fear of loss of control is one more "what if" fear. It does not happen -- phobic people do not act panicky or irrationally -- even though they feel that they "might." This is a vitally important point in the treatment of phobic people. Those who fear driving do not lose control in a car, for example, even when they feel their full-blown phobic panic feelings after years of not driving. Similarly, phobic non-flyers often fear they will panic and lose control of themselves in an airplane if they fly. This does not happen. What does happen, especially early in treatment, is the phobic person may leave the airplane prior to take-off. However, once the door is closed, despite feelings and anticipation to the contrary, phobic people do not panic or act irrationally.

Note that many phobic fears involve technologies. As new technologies have been introduced, each produced widespread public fears. Cars, trains, airplanes, natural gas, and electricity brought into the home, for instance, all produced widespread fears when they were introduced. The initial fears soon subsided for most people as the technologies became more familiar. This reduction occurred almost without regard to the actual danger of the technologies involved. For example, riding in an automobile is not "safe," in any absolute sense, but few people are afraid to ride in a car in America today. Sad to say, there is so little fear that more than 80 percent of Americans do not use seat belts, which could save at least 25,000 lives a year (Ref. 5).

This observation makes clear the often irrational aspect of fears and the extent to which they are not based on real risks to health or even to life itself. While the vast majority of the public quickly learns to accept new and potentially dangerous technologies, this process is not universal: fear of flying in airplanes remains common -- about 25,000,000 Americans are afraid to fly -- despite the excellent safety record of commercial aviation (Ref. 6). I will return to this example later because it has major parallels to the fear of nuclear power.

There are several factors, however, which combine to make fear of nuclear power unique. The first is that it is a relatively new technology. Second, nuclear power is associated in many people's minds with deadly nuclear weapons. Third, the dangers of nuclear power seem mysterious because radiation cannot be sensed directly and because if harmful exposure has occurred, effects can be delayed and uncertain. Fourth, the "what if" risk of nuclear power is seen as "imposed," rather than voluntarily accepted: thus, one may, as an individual, choose to get on an airplane or to avoid it, while potential risks from nuclear power, however small they may be, are not always chosen by the individual on whom they fall. Fear of nuclear power has also proved more persistent than many other fears because, in contrast to such phobic stimuli as bridges, automobiles or airplanes, few people come in contact with nuclear power plants precisely because there are relatively few of them and because federal regulations restrict public visiting of the plants. Fear of nuclear power, in contrast to most other phobic fears of technology, is spread and reinforced by political and media voices.

To recap: The fear of nuclear power has phobic elements because it is a "what if" fear. Like the fear of most new technologies, it is widespread. Several factors make fear of nuclear power more common, more severe, and more persistent than fears of other technologies.

III. The Major Psychological Forces Behind Fear of Nuclear Power

There are four easily understood, but irrational, psychological factors at work distorting the public perception of risk from nuclear power. The first is whether the risk appears to be from one single big event or from many smaller events spread out over time and space. The risks associated with single, big events seem worse than those associated with distributed risks. To understand this factor, compare the fear produced in the public by an airplane crash with that produced by an automobile crash. On January 13, 1982, a plane crashed into the Potomac River in Washington, D.C., producing front-page news all over the world, not just for that day, but day after day. Even the Federal Aviation Administration hearing into the causes of the crash was widely reported, and much of it was carried live on National Public Radio. A total of 78 people died in that tragic accident (Ref. 7).

On that same day, approximately 134 people died equally tragically in car crashes in the United States (Ref. 8). What was the news value of the story about the highway deaths on January 13, 1982? Think about it: 134 died the next day and the next day and the next. The only way highway safety hits the headlines is if many people or many cars are involved in a single accident and, even then, the media coverage is minimal and usually local, as compared to that of plane crashes.

It is, therefore, not surprising that 25,000,000 Americans are so afraid to fly that they either do not fly at all, or severely curtail their flights. It is also not surprising that Americans do not fear driving a car and most do not wear seat belts, although some public health experts believe this would reduce their risk of death and injury by at least 50 percent (Ref. 9).

The manner in which the media report stories about risks reinforces this exaggeration of one kind of risk and the minimization of the other. In reporting on nuclear power, in contrast to reporting on both airplanes and automobiles, there have been no deaths at all to write about. The nuclear news is about conflict, controversy, and accidents. These are often relatively minor industrial accidents. In over 25 years, there has never been an accident which has harmed the public and yet they are big news. The news is the "what if" element of the story. This kind of news reporting perpetuates the irrational fear of nuclear power.

In reporting on accidents at nuclear power plants, it is common for the media to report reassuring statements from the operators of the plants or from the Nuclear Regulatory Commission about the absence of health dangers. These reassurances are then "balanced," directly or by implication, with fear-inducing quotes from the opponents of nuclear power, who are often identified as "public interest" groups. These "public interest" quotes are generally "what if" messages that reinforce the fearful person's "what if" fears. One particularly egregious example of this reinforcement is the sponsorship or distribution by the New York Public Interest Research Group, Inc. of the pamphlet and survey discussed in the Power Authority's Motion to Exclude Fear As An Issue In This Proceeding (Dec. 1, 1981). As I said in my affidavit in support of that motion, these documents "are explicitly designed to generate a fear reaction in the reader. These documents promote phobic thinking about nuclear power." Affidavit of Dr. Robert L. DuPont In Support of the Power Authority's Motion to Exclude Fear As An Issue In This Proceeding ¶ 6 (Dec. 1, 1981).

The second factor in the public's perception of risk which deeply affects attitudes toward nuclear power is the distinction between risks that the individual personally controls or thinks he controls and risks perceived to be controlled by others. We tolerate with relative ease those risks which we feel we can control; but, when risks appear to be imposed by others, we find them intolerable. Driving a car is a risky activity, but it is comfortably done by millions of Americans. The anti-nuclear political movement is based on the idea that nuclear power is an "imposed" risk: the ordinary citizen does not choose this risk and, therefore, it is unacceptable. Rational discussion of how big the risk itself is, or how it compares to other, more familiar risks, is thus avoided. In modern life, it is the issue of who controls the risk which activates political reactions to dangers of all kinds.

Think about an anti-nuclear demonstration -- about the mass of people blocking the gate to a nuclear power plant, for example. Then think about when you last saw a group of protesters blocking the gate to a distillery. Nuclear power plant accidents have killed no one; alcohol kills about 200,000 Americans a year, over 500 each day (Ref. 10). Why not protest drinking alcohol? When was the last time a political movement got up a head of steam about the 90 percent of Americans who do not wear seat belts when driving or riding in their cars? This is one of the factors that distinguishes fear of nuclear power from fear of airplane crashes. Because the passenger voluntarily chooses to fly, there is no political opposition to flying. The fear of flying is not reinforced by a vocal and visible group of experts and political activists lending the fear an appearance of scientific and political legitimacy.

Note that nuclear power is not really an "imposed" risk at all, even though the anti-nuclear movement exploits the appearance that it is "imposed." The reality is that the existence of nuclear power in the United States is the result of an open, democratic political process involving the national political will. The risks of nuclear power are entered into by such shared decision-making.

The third factor in the public's perception of risk is whether the risk is familiar or unfamiliar. Familiar risks seem smaller, and unfamiliar risks seem greater. This principle underpins successful treatment of phobias. The elevator phobic, for example, is cured only by the sufferer's repeated exposure to an elevator. The challenge is to get the phobic person into the elevator -- that is the hard work of treatment. Once the exposure occurs and is repeated, the fear diminishes, and elevator riding becomes easier.

When considering this third factor in the public's perception of risk, recall that most Americans have never knowingly seen a nuclear power plant, even at a distance. Also recall that Nuclear Regulatory Commission regulations restrict access to nuclear power plants. These regulations are an example of the extraordinary caution exercised by the Commission to ensure public safety. An unfortunate side effect of these well-meaning regulations, however, is that the public remains unfamiliar with nuclear power plants. Thus, in contrast to most other fear-producing technologies, such as cars and airplanes, the increasing familiarity that would help to reduce the fear of nuclear power has not occurred.

Fourth, and finally, fears are exaggerated if the feared stimulus is thought of as unnecessary and/or unpleasant. By contrast, when the feared experience is considered necessary or pleasant, it is rarely feared, regardless of the actual risk involved. Alcohol consumption, particularly when combined with driving, another risky venture, is a good example of this. Even though nuclear power provides about 12 percent of all American electricity, many Americans are convinced that nuclear power is an unnecessary source of electric power generation. Given this appearance of being unnecessary, the anti-nuclear argument goes, "Why put up with the fear?"

The psychological deck is stacked against nuclear power. All four of these factors work to heighten irrational fears of nuclear power.

To recap, nuclear power is seen by many Americans as posing a "single, big threat" and is, therefore, excessively feared. This fear is reinforced by the media. Nuclear power is seen as controlled by "others" and, therefore, the fear is exaggerated. Nuclear power is unfamiliar and, therefore, the fear persists. Nuclear power is seen as unnecessary and, therefore, the fear is not confronted, but permitted to flourish.

IV. The Potential for Overcoming Fear of Nuclear Power

There are two major lessons from understanding the psychological roots of the fear of nuclear power which have direct applicability to overcoming the fear.

The first is putting the health risk of nuclear power into a realistic, "what is" perspective. It is essential that the discussion of health risks be presented to the public in a clear, realistic way. The dangers of nuclear power need to be understood in relationship to the dangers of other ways of generating electricity and also in relationship to other, more familiar, health risks. Once the leap is made to "what if" thinking in considering health risks, that leap needs to be clearly labeled and the related "what is" risks need to be similarly explored.

The phenomenon of "what if" thinking must be understood. Those in positions to make decisions for their fellow citizens and to educate and influence the public must be "what is" thinkers. Only then can the risks of nuclear power, and the health hazards of modern life which are truly menacing, be rationally evaluated. While facts alone will not overcome irrational, phobic fears, facts are important. They will reduce the likelihood of fear reactions developing and, once they begin to develop, facts about safety will help the fearful person accurately identify the source of the problem: inside himself and not in the fear-provoking stimulus. Facts also help those around the fearful person identify the problem as irrational fear, thus facilitating effective response to the problem.

Second, and I speak now as a practicing physician, it is important to address the needs of the fearful person. The first step in overcoming any excessive or irrational fear, including fear of nuclear power, is to face the reality that the fear is the problem (not the nuclear power plant) and that the fear is inside the frightened person. This concept may sound simple, but it is difficult because the fearful person attributes his fear to external stimuli -- in this case, a nuclear power plant. I wish that people who are afraid of nuclear power could visit a nuclear power plant, as I have done. In the course of visits I have made, my own initial fears were reduced by seeing how work-a-day the plants actually are. I also found it reassuring to meet the people who work in nuclear power plants. They appeared to me to be well-trained, "good," and unafraid people. I also enjoyed spending time in the visitors' centers, which most of the nuclear power plants now have. There I learned a good deal about nuclear power and about energy.

Additionally, school children should be educated about nuclear power and the energy problems facing our modern world. This must, however, be a "what is" education. It is the responsibility of our educators to contribute to the development of tomorrow's rational decision-makers, rather than to promote a generation of voters who can only think in a "what if" manner.

V. Conclusions

While nuclear power tends to generate fear, there is nothing unique about the fear itself. The psychological principles involved in this fear, as well as the impact of the media and politicians, are not unique. The major lesson from understanding the widespread public fear of nuclear power is that, as our world changes ever more rapidly, we need to think twice about our innate, automatic fear reactions. We also need to recognize the ways our fears are wittingly and unwittingly affected by voices from the political arena and from the media. We need to be able to refocus on the most serious dangers to our health, individually and collectively, and to take sensible actions to reduce those threats.

When we come against fears which are not well-founded on scientifically proven facts, we need to use specific techniques for overcoming these fears by facing them directly. It is especially important that the media and our political leaders become better educated about where risks to health are located so they can help solve these problems, rather than distorting them further, as often happens today. To let our fears, themselves separated from realistic assessments of danger, dominate our actions as individuals or as a nation would be a real tragedy, posing a grave threat to our health, our happiness, and our productivity.

While increased familiarity and knowledge regarding nuclear power may help to reduce unrealistic fears, the encouragement of "what if" thinking about events with a remote probability of occurrence will certainly heighten those fears. Just because an event has a probability of occurrence that is "greater than zero" does not mean people should be fearful. Any event, whether tragic or desirable, has a probability of occurring that is "greater than zero." We must rationally assess the "what is" concerning risk in order to reassure the community that decisions are being made in a prudent, rather than an irrational manner. Even people who are excessively frightened of nuclear power conduct other aspects of their lives based on "what is" thinking.

Let me turn now to "what if": what if there were an accident at Indian Point that required public protective action? There has never been an accident at a nuclear power plant necessitating a prompt or general public response, a record which speaks well for the nuclear industry and its regulators. Despite the lack of direct data regarding "nuclear" evacuations, I believe that during such an evacuation people would behave responsibly and competently. They did just that (and without the benefit of an evacuation plan) in February 1981, when approximately 3000 people were evacuated in Port Jervis, Orange County, New York, due to river flooding (Ref. 11), and in November 1979, when approximately 250,000 people were evacuated in Mississauga, Ontario, Canada, due to a chemical spill (Ref. 12).

Based on my experience with human behavior, particularly behavior under stress, I believe that elected officials will be cooperative and competent, that school officials and teachers will be sensible and responsible, and that neighbors will be helpful and humane. If this were not the case, we would long ago have ceased trusting the public officials who we know, our personal physicians, our children's teachers, our neighbors, and ourselves.

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ROBERT L. DUPONT, M. D.

BIOGRAPHICAL SKETCH

Robert L. DuPont, M. D., is a practicing psychiatrist and President of the non-profit Institute for Behavior and Health, Inc. (IBH). As part of his practice of psychiatry, he directs Washington's first phobia treatment program. In addition, he is President of the American Council on Marijuana and contributes to local and national TV, radio, magazines, and newspapers on a variety of health topics.

The American Council on Marijuana is the nation's leading private organization linking scientists to community action programs. It interprets the latest scientific research for the public and offers leadership on marijuana policy. The American Council on Marijuana and Other Psychoactive Drugs was founded in 1977. ACM has offices in New York City and Rockville, Maryland.

Dr. DuPont has a special interest in substance abuse prevention programs in the schools and in the workplace. The Institute for Behavior and Health conducts research and demonstration programs aimed at preventing drug and alcohol abuse, as well as more broadly targeted health promotion efforts.

The Phobia Program of Washington is a structured 20-week program which helps phobic people overcome agoraphobia, fear of flying, fear of driving on major highways, claustrophobia, and other phobias. The program, which was founded in 1977, also includes self-help meetings for former program members, and outreach services for housebound agoraphobics. In May, 1978, Dr. DuPont chaired a Special Session at the American Psychiatric Association's annual meeting in Atlanta on the "Treatment of Phobias." He chaired a similar Special Session at the 1979 APA meeting in Chicago and the 1980 APA meeting in San Francisco. In 1980 he led the second annual National Phobia Conference held in Washington, D. C.

In addition to his work as a health commentator on ABC-TV's Good Morning, America, Dr. DuPont has appeared on many network TV shows, including The Phil Donahue Show, The David Suskind Show, and The Dick Cavett Show. He is a frequent guest talk-show host on WRC-NBC radio in Washington, D. C. He has been quoted in U. S. News and World Report, Time and Newsweek, and has appeared on the evening network news, the Today Show, and many TV documentaries.

Dr. DuPont was the Director of the National Institute on Drug Abuse from its creation in September, 1973, until July, 1978. In June, 1973, he was appointed by the President and confirmed by the Senate to direct the White House Special Action Office for Drug Abuse Prevention, a position he held until the office terminated in June, 1975. As SAODAP Director with a staff of more than 100, he designed and coordinated the entire $1 billion a year federal drug abuse prevention program.

In his role as Director of the National Institute on Drug Abuse, he directed the Federal Government's major drug abuse treatment, research and prevention effort with a staff of 400 and a budget of $280 million a year.

From 1970 to 1973, Dr. DuPont served as Administrator of the Narcotics Treatment Administration (NTA) of the District of Columbia Department of

Human Resources. NTA was a comprehensive city-wide multimodality heroin addiction treatment program which treated 15,000 people with a staff of 500 working in 20 facilities during those years.

As a research psychiatrist and Acting Associate Director for Community Services of the District of Columbia Department of Corrections from 1968 to 1970, he directed the city's parole and halfway house programs and developed a pilot narcotics treatment program.

Dr. DuPont has written more than 100 professional articles and one book on a variety of topics in the fields of health promotion, drug abuse prevention, and criminal justice. He holds the faculty positions of Clinical Professor of Psychiatry at Georgetown University Medical School, and Visiting Associate Clinical Professor of Psychiatry at Harvard Medical School.

He is a diplomate of the American Board of Psychiatry and Neurology, a fellow of the American Psychiatric Association, and a member of many professional organizations, including the Academy of Behavioral Medicine Research, the Behavioral Medicine Special Interest Group, the American Public Health Association, the World Psychiatric Association, the Pan American Medical Association, the Medical and Chirurgical Faculty of the State of Maryland, and the Montgomery County Medical Society. Dr. DuPont was Chairman of the Drug Dependence Section of the World Psychiatric Association, from 1974 through 1979.

Dr. DuPont is listed in Who's Who in America and has received honors, including being chosen the Outstanding Young Man in the District of Columbia Government in 1972 by the Downtown Jaycees. In 1973, he was given the Meritorious Service Award by the Mayor of the District of Columbia. He was awarded the highest honor in the U. S. Public Health Service, the Superior Service Award, by the Surgeon General in 1978. He has also been honored by several local and national drug abuse and alcohol abuse prevention organizations.

Born on March 25, 1936, in Toledo, Ohio, he attended public high school in Denver, Colorado; received a B. A. from Emory University in Atlanta, Georgia, in 1958; and an M. D. from Harvard Medical School in Boston, Massachusetts, in 1963. His postgraduate training includes: Medical Intern, Cleveland Metropolitan General Hospital, Western Reserve Medical School (1963-1964); psychiatric resident and teaching fellow, Massachusetts Mental Health Center, Harvard Medical School (1964-1966); and clinical associate, National Institutes of Health (1966-1968).

June 1, 1982

ROBERT L. DUPONT, M. D.

SUPPLEMENTAL BIOGRAPHICAL SKETCH

Material Pertaining to Fears of Nuclear Power:

In 1979, because of his experience with public policy and his expertise in fear, Dr. DuPont was asked by the non-profit Media Institute to review network TV news coverage of nuclear power between 1968 and 1979. This led to publication of the influential monograph, "Nuclear Phobia -- Phobic Thinking About Nuclear Power."

Subsequently, Dr. DuPont visited nuclear power plants at Three Mile Island, and Peach Bottom in Pennsylvania, and Diablo Canyon in California, as well as England, Canada and France. In addition to talking to employees at these nuclear power plants, he interviewed neighbors and county and regional leaders, including physicians and politicians. He has consulted with numerous utilities, public interest groups, medical groups, and government agencies about public reactions to nuclear power.

In October of 1981, Dr. DuPont participated in an international Conference at Ditchley Park in England dealing with the media coverage of energy in five countries: England, France, Germany, the United States and Japan.

His publications on the psychology of nuclear power include the following:

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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Frederick J. Shon
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In the Matter of CONSOLIDATED EDISON COMPANY OF NEW YORK, INC. (Indian Point, Unit No. 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point, Unit No. 3)	Docket Nos. 50-247 SP 50-286 SP Jan. 24, 1983

CERTIFICATE OF SERVICE

I hereby certify that on the 24th day of January, 1983, I caused a copy of Power Authority's Testimony of Robert L. DuPont, M.D., on Commission Question 1 to be served by first class mail, postage prepaid on the following:

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#8

ERRATA

Page 1, line 13, "Ditckley Par" should be changed to "Ditchley Park"

Page 3, line 7, "25" should be changed to "23"

Page 23, reference 3 should be changed to "Letter from Timothy L. Smith, Senior Buyer Statistician, Office of Buyer Statistics, New York State Department of Health, Office of Public Health, to Helen Lardner, Morgan Associates (January 25, 1983) (Enclosure)."

BY MR. COLARULLI: (Resuming)

Q Dr. DuPont, could you give us a brief summary?

JUDGE GLEASON: I think we are all familiar enough with the testimony that we could waive the summary.

MR. COLARULLI: Your Honor, we would appreciate it if we could extend that courtesy to Dr. DuPont.

JUDGE GLEASON: All right.

WITNESS DUPONT: I will be very brief, Mr. Chairman. The basis of the testimony is based on my clinical experience in treating several hundred phobic people in a study I have done for the Media Institute by television news coverage of nuclear power, and visits to a variety of nuclear power plants in this country and abroad, speaking to people who work there, and neighbors, and people who live there, as well as testimony and reading and presentations I have made.

The key concept of phobic thinking that I think applies and is useful in understanding public reactions to nuclear power has to do with the concept of what-if thinking, and I outline that in my paper. I want to make clear that the concept of what-if thinking is not based on an assumption of zero risk involved in the things that people are phobic about. I also want to make clear even in this brief summary that I am not saying that all people who oppose nuclear power are phobic, and I am not applying clinical diagnoses to these people.

I am merely saying that phobic thinking, a way of thinking about risk, is a predominant thing in the public reaction to nuclear power. The paradox that I explore is the paradox of relative public safety over the course of 25 years of existence of nuclear power in the face of large-scale public fear of this source of energy.

I outline the reasons why I think this exists. I won't go through those now. But let me summarize the final point on this particular point, III.C, about behaviors in emergencies.

It has been my experience in working with many clinically phobic people as well as being involved in emergencies, including evacuations, personally, that emergencies bring out in phobic people and others not social disorganization but social cohesion, and although phobic people often anticipate that they will lose control of themselves in an emergency, their actual performance in an emergency is quite good.

For example, this will be a woman who is not able to drive a car. When an injury occurs or an emergency occurs to a child, she will jump in the car and be able to drive a car. This distinguishes phobic behavior from the behavior of people of many other categories of mental illness, including most psychotic disorders.

That concludes my summary.

JUDGE GLEASON: Thank you.

MR. COLARULLI: Your Honor, the witness is available for cross examination.

JUDGE GLEASON: Mr. Blum.

CROSS EXAMINATION ON BEHALF OF UCS

BY MR. BLUM:

Q Dr. DuPont, are you afraid of sharks?

A (WITNESS DUPONT) Sharks?

Q Yes.

A (WITNESS DUPONT) It would depend on the situation. Generically right now I don't have a serious fear of sharks.

Q If you were swimming in the ocean and a shark was ten or fifteen feet away from you, would you feel very much afraid of that shark?

A (WITNESS DUPONT) Well, it depended on how much I knew about being in the ocean and swimming near a shark. It is my understanding that people who have a good bit of experience with that often are not fearful. I would be fearful because I am not familiar with that experience.

Q Are you aware generally how many Americans have been killed by sharks?

A (WITNESS DUPONT) No, but I think it would be a small number.

Q In fact, it would be much smaller than the number of people who have been killed by radiation, would it not?

MR. COLARULLI: Your Honor, I object to that question. Killed by radiation in what form? Is he talking about nuclear power accidents again?

MR. BLUM: To clarify for Mr. Colarulli, this would refer primarily to radiation exposure which has not come for the most part from nuclear power reactor accidents, but from delayed cancer deaths due to exposure of veterans in the Army in atomic tests.

MR. COLARULLI: Your Honor, I still object. There is testimony in the record from intervenors' witnesses that they could not specify any nuclear power accidents that have led to cancer. I still think the question is unfounded.

JUDGE GLEASON: Ask another question. Rephrase it somehow. Let's get on with this, please.

Now, Mr. Kaplan, he really does not need help.

MR. KAPLAN: Your Honor, I will refrain from making an objection. I am trying to move it along.

JUDGE GLEASON: I know, but you are really spending our time.

MR. BLUM: Mr. Kaplan does have a point, although we don't need to spend any time on it right now.

BY MR. BLUM: (Resuming)

Q Dr. DuPont, at the bottom of Page 2 of your testimony, you state that no member of the public and no nuclear worker has been killed as a result of irradiation or a nuclear accident anywhere in the United States. Do you still believe that statement to be true?

A (WITNESS DUPONT) In relationship to commercial nuclear power generation, I believe that is true. Yes, sir. That is the context of that sentence.

Q So you would not include other nuclear power reactors that are not commercial?

A (WITNESS DUPONT) Absolutely. I agree with you completely. To go to the thrust, do I believe that radiation can kill people, the answer is, yes, sir, I do.

Q Thank you.

JUDGE GLEASON: Dr. DuPont, if you would just restrict your answers to his questions, I think we will move much more quickly.

Q Dr. DuPont, do you believe that people who are afraid of sharks in the sense that they would not want to be swimming near one in the ocean are phobic?

A (WITNESS DUPONT) No, I do not.

Q Are you aware, Dr. DuPont, that the conditional probability, or maybe we will just say the probability of a shark attacking someone ten or fifteen feet away from them in the ocean is substantially lower than the probability that a core melt accident at a nuclear power plant will lead to breach of containment and release of radiation?

A (WITNESS DUPONT) I was not aware of that, but I was prepared to accept that. You are reducing my fear of sharks quickly here.

Q In your testimony, you state that people who have safety concerns about nuclear power are not themselves phobic, but there is an analogy between the way they think and having a phobia.

A (WITNESS DUPONT) No, I don't agree with that as a characterization of my statement.

Q You do claim that they do have phobia. Is that correct?

A (WITNESS DUPONT) People who are concerned about the nuclear power plants, I don't think most of them are phobic at all. No, sir.

Q Well, the people you are referring to in your testimony, how would you describe these people, the people --

JUDGE GLEASON: He refers to all kinds of people in his testimony.

WITNESS DUPONT: I think we have to talk about what people we are talking about, under what circumstance.

BY MR. BLUM: (Resuming)

Q All right, let's talk about intervenors opposed to nuclear power.

A (WITNESS DUPONT) I don't think many of the intervenors are phobic.

Q But there is an analogy between how they think and phobia. Is that correct?

A (WITNESS DUPONT) No. As long as we are clear on the differentiation between a what-is and a what-if, I have no quarrel with that, and I think to be concerned about what-if fears is perfectly reasonable. I think many people in the public are confused on this point, and are reacting to what-if statements as if it were what-is, people who, for example, on my visit to the

Three Mile Island area, would not drive down the road past the plant because they were concerned about their safety. I think that is an unrealistic or a phobic concern. I never noticed anybody from the intervenors' group who would be afraid to drive near a nuclear power plant.

Q All right. You have identified the group of people now. It is the ones who confuse what is and what if.

A (WITNESS DUPONT) Exactly.

Q Now, these people, you do not claim that they have phobia in the clinical sense of phobia?

A (WITNESS DUPONT) That's right.

Q But you do claim there is an analogy between how they think and phobia?

A (WITNESS DUPONT) I do.

Q And you are an M.D., are you not?

A (WITNESS DUPONT) I am an M.D.

Q If someone came to you with a common cold, you could correctly say to them, could you not, that there is an analogy between what you have and terminal cancer, that is, that both are incurable viruses. Is that not correct?

A (WITNESS DUPONT) Well, I don't think the definition of cancer as an incurable virus is a correct statement of our understanding of cancer. No, sir.

Q Well, there are certain types of cancers --

A (WITNESS DUPONT) In animals, not in humans, as far as we know, although that is an interesting question that is being discussed, but I don't think it has ever been proved that cancers in humans are caused by virus.

JUDGE SHON: Doctor, what about Burkett's lymphoma?

WITNESS DUPONT: I am not saying there is none, but this is not conceptually -- I wouldn't say to the person who has a common cold -- I don't think that would be helpful to him.

JUDGE GLEASON: Let's get these questions out of the abstract and into his testimony, please.

MR. BLUM: Well, I think that is what we are trying to do.

JUDGE GLEASON: Well, you are not doing it very well, Mr. Blum, if you are trying to pierce what his knowledge is of phobia.

MR. BLUM: I am trying to get into the meaning of the statement of his where he says it is not phobia, but it is analogous to phobia.

JUDGE GLEASON: All right, we will accept that. That is his statement.

BY MR. BLUM: (Resuming)

Q But isn't it true that all kinds of things are analogous to all kinds of other things?

JUDGE GLEASON: You really shouldn't even want a statement like that to appear in the record.

MR. BLUM: All right. I will withdraw the question, then.

BY MR. BLUM: (Resuming)

Q Dr. DuPont, you have mentioned a fear of snakes, this being involved with phobia sometimes.

A (WITNESS DUPONT) I don't recall mentioning fear of snakes, but I will be glad to discuss that.

Q That is not necessary. But I would like to refer to a particular situation and ask you a question about it.

A (WITNESS DUPONT) All right.

Q My sister used to walk to school through a field that was a slight shortcut, and one day she heard a rattlesnake rattling in the field. This was in southern California. And after that she decided that she would still go to school, but she would not walk through that field any more. She walked on the road, which was slightly longer.

Would you characterize my sister as having a phobic response there?

A (WITNESS DUPONT) I think it would be a question of what kind of risk reduction really was involved in that. That is a hypothetical question. I am not real comfortable with it, because it involves making a judgment about what her risk is in that field. And I am not clear on that. But an example of the same kind of thing is a person who has an automobile accident and then becomes phobic of driving. I mean, that to me is a much more common clinical experience. Your sister wasn't bitten by a rattlesnake.

Q I was trying to get at something else. Now, she had walked through that field hundreds of times and never heard a rattlesnake before.

A (WITNESS DUPONT) Right.

Q So we could truthfully say, could we not, that she -- that the probability of her being bitten by a rattlesnake in that field was probably quite low, because to get it we would have to both have a rattlesnake present there --

A (WITNESS DUPONT) Yes.

Q -- and multiply that by the fact that it would be in her path.

A (WITNESS DUPONT) Right.

Q And multiply that by the fact that it would in fact move to bite her.

A (WITNESS DUPONT) Yes.

Q And further multiplied by the fact that she would not successfully evade the snake.

A (WITNESS DUPONT) And we would also have to add he risk of her walking by the road and the alternative of being hit by a car.

Q So it is also true that being bitten by a rattlesnake would have had a rather indeterminate probability. It would be hard for us to characterize it precisely, would it not?

A (WITNESS DUPONT) Correct.

Q So we have a situation where my sister, confronted with a very low probability of being bitt by a rattlesnake, but substantial uncertainty about the exact probability, and a fairly low cost to her involved in not going through that path, chose not to do it.

A (WITNESS DUPONT) Yes.

Q Now, my question is, was my sister acting phobically or was she just choosing to minimize a certain kind of risk?

A (WITNESS DUPONT) Well, again, to go back to the clinical definition of phobia, we have to know a little bit more about what was going on inside your sister at that time. If she developed, for example, a reaction, a fear reaction in association with that field or even the thought of that field, that could very well be a phobia. If she just said, well, there is an easier way to get there and it is not much of a problem, and that is what I am going to do, I don't think that would be a phobia. So we would have to know a little more about it, I think, to say whether your sister was phobic or not.

Q Dr. DuPont, are you aware of something called the Price-Anderson Act?

A (WITNESS DUPONT) I wouldn't consider myself an expert on that. I am familiar with it.

Q And you are aware that the insurance industry in the United States chooses not to ensure against nuclear accidents?

A (WITNESS DUPONT) I am not sure I know that, no. My understanding is, there is commercial insurance available, but it is a limited amount, but I don't know the answer. I'm not an expert.

Q Do you know whether it is possible to buy homeowner's insurance that insures against the risk of a nuclear accident?

MR. COLARULLI: Your Honor, I would object to this line of questioning as being outside the scope of his testimony.

WITNESS DUPONT: It is certainly outside of the area of my expertise.

MR. BLUM: Well, part of the problem is that the testimony covers many areas that are outside of his expertise.

MR. COLARULLI: Your Honor, we object to that characterization.

JUDGE GLEASON: Well, you know, time is passing and you are not being very productive, Mr. Blum.

MR. BLUM: I would agree that this is not at the heart of the proceeding. I don't think I have too much longer to go on with this witness.

BY MR. BLUM: (Resuming)

Q Dr. DuPont, on Page 10, you make a statement, and I would like to read you the statement and then ask you the question, isn't this simply a rather incredible statement? The statement -- you are describing what happens to a phobic person when you go ahead and force the phobic person to endure the thing they are afraid of anyway, and you say, "However, once the door is closed, despite feelings and anticipation to the contrary, phobic people do not panic or act irrationally." Isn't that a rather incredible statement applied to all phobic people?

A (WITNESS DUPONT) Well, I suppose there is some truth to that. I cannot apply it to all phobic people. I have worked with probably 200 people who have fears of flying, and this does describe what happens, that many of them -- most of them fear that they are going to lose control of themselves on the airplane. To my knowledge, none ever has.

I checked with the person in charge of passenger problems for Eastern Airlines if they had ever had anybody lose control in an airplane because of anxiety and phobia, and to this woman's knowledge they had never had a single person in the entire Eastern Airlines system.

Now, that doesn't mean that there isn't some somewhere. Now, it is incredible, in contrast to the fear of loss of control, but it does reflect my clinical experience.

Q Dr. DuPont, I have one friend who is afraid of flying, but when he goes on a plane he becomes catatonic from the whole trip.

A (WITNESS DUPONT) He may sit very still, and that is what catatonic means. One of the ways of flying for those who are phobic on an airplane is to sit very still. That is true.

Q So sitting very still in a state of disoriented terror, you would not characterize this as panicking?

A (WITNESS DUPONT) No, I wouldn't call it loss of control. He doesnt' act berserk.

Q All right. Thank you, Doctor.

There was a certain contention the intervenors had put into this proceeding which some of us had doubts about whether we wanted it in the proceeding, and we had doubts about getting a witness who would support it, although I think with you we may have now found the witness, if I could ask a couple of questions.

You believe that a substantial number of people have rather strong and exaggerated fears of nuclear power. Is that correct?

A (WITNESS DUPONT) I think many people are afraid. Yes, sir.

Q And in some instances this approaches a level of phobia. Is that correct?

A (WITNESS DUPONT) I have seen people, as I mentioned, who wouldn't drive by a nuclear power plant, for example, that kind of thing, or would be very anxious about having a family member work in a nuclear power plant. In that sense, it is phobic.

JUDGE PARIS: Could I interject a question? Have you seen those in any place other than Three Mile Island?

WITNESS DUPONT: I have not seen people otherwise clinically, but I wouldn't be surprised that such people exist who are actually changing their behavior. I think it would be a fairly small number, but I think the number of people who would be anxious or concerned would be fairly large.

MR. BRANDENBURG: Dr. Paris, I hesitate to interject here, but I recall a witness who testified on Question 3 and 4 in a much earlier time. I believe it was a police chief or something like that. He stated that home purchasing arrangements were affected in the area of Indian Point due to the presence of the plant.

MR. KAPLAN: I would ask that whatever Mr. Brandenburg said other than the preamble or the substance, he can place that in his findings of fact. I ask that it be stricken from the record.

JUDGE GLEASON: Let's go on, please. Mr. Blum.

BY MR. BLUM: (Resuming)

Q Dr. DuPont, people in phobic states are undergoing rather great psychological stress, are they not?

A (WITNESS DUPONT) That is correct.

Q And great psychological stress is often associated with psychosomatic bodily disorders, is it not?

A (WITNESS DUPONT) You mean, like ulcers, for example?

Q That would be one good example.

A (WITNESS DUPONT) Well, Mr. Blum, the studies about psychosomatic disorders among phobic people suggests there is no excess of these disorders among phobic people, and that is very surprising, because most of them feel that because of, as you say, the stress they are under, that they are at greater risk of these disorders.

Q Could you specify which disorders in particular?

A (WITNESS DUPONT) Well, the kind of things you are talking about, asthma, heart attack, stroke, various kinds of ulcers, you mentioned, stress-related illnesses in general. There is one study to the contrary which was recently published, but basically the findings have been, as I say, that phobic people are not at greater risk of these disorders than a similar group in the population.

Q But there does tend to be a relationship between one type of mental illness and another. Is that not correct?

A (WITNESS DUPONT) Not with phobias. No, I don't believe so. Phobic people generally are mentally quite healthy outside of the areas of phobia, like your friend with the fear of flying. I would assume he is otherwise quite normal.

Q Dr. DuPont, are you familiar at all with the art of probabilistic risk assessment?

A (WITNESS DUPONT) Yes, but I am not an expert in that area.

Q Yes, I know. Would you characterize probabilistic risk assessment as being what-is thinking or what-if thinking, in your terms?

MR. COLARULLI: Your Honor, I would object to that as being --

JUDGE GLEASON: Objection granted.

MR. BLUM: I have no further questions.

JUDGE GLEASON: Are you responding to III.2?

MR. HARTZMAN: I was --

JUDGE PARIS: Answer yes or no.

MR. HARTZMAN: No.

JUDGE GLEASON: Otherwise, you can't ask questions.

MR. HARTZMAN: I thought it was only on Board questions.

JUDGE GLEASON: No. The direction was, it has to be asked by the lead intervenor.

MR. HARTZMAN: Well, again, as I understand the April 23rd order, that two intervenors should have an opportunity to cross examine.

JUDGE GLEASON: Well, make your questions brief, Mr. Hartzman.

MR. HARTZMAN: I think they will be brief, Your Honor.

CROSS EXAMINATION ON BEHALF OF FOE AUDUBON

BY MR. HARTZMAN:

Q Would you turn to Page 13 of your testimony, where you state at the top of the page, the risks associated with single big events seem worse than those associated with distributed risks, and then you draw a comparison between an air accident that occurred with 78 deaths and on the same day 134 deaths from auto accidents, and then you go on to say that approximately 134 die every day in the United States.

If there were a single air crash each day in the United States which took 134 lives, this occurring every day over, you know, as a common matter, would this only seem worse than the accidents from auto deaths,

deaths from auto accidents?

A (WITNESS DUPONT) I don't know what you mean, would it seem worse.

Q You state that the risks associated with single big events seem worse than those associated with distributed risks. I presume you are saying that deaths from auto accidents are distributed risks.

A (WITNESS DUPONT) Yes, that's right.

Q And I am asking, if there were 134 deaths each day from a single airplane accident, would that only seem worse than the risk associated with those auto accidents?

A (WITNESS DUPONT) Well, one assumption that I make is death from any cause is proximately equivalent to death from any other cause, so 134 deaths from one cause would be as serious a public health problem as 134 deaths from some other cause.

Q So the public should have no greater concern from an air accident every day taking 134 lives than they now have concerning 134 lives taken from auto accidents?

A (WITNESS DUPONT) In terms of protection of public health, I believe they would be equivalent problems.

Q Well, let me ask you this. If there were 134 deaths a day, that comes to about 50,000 deaths annually. Is that correct?

A (WITNESS DUPONT) That's correct.

Q If there was one earthquake in California each year which took 50,000 lives, would that be of some greater concern than the cost of lives from auto accidents in the nation?

A (WITNESS DUPONT) It wouldn't be to me as a person concerned with public health. I would consider it equivalent. A hundred and thirty-four deaths from one cause is just as serious a matter in terms of public health as 134 deaths from another, or 50,000 deaths. I don't quite understand why you think they are different, which is what --

Q So you are saying we should have no greater concern about catastropic accidents than from smaller distributed accidents? Is that your position?

A (WITNESS DUPONT) I think a death is a death is a death. And they are all very much of concern. I don't think one is more serious than another. That is correct.

Q You indicate in your testimony that the public has a misperception of the risk of nuclear power accidents, or the risk of nuclear power.

A (WITNESS DUPONT) That's right.

Q And what is the basis for that conclusion, that the public has a misperception?

A (WITNESS DUPONT) Well, there have been a number of studies done in which the public is asked what the risks are to their health from various sources, and what those studies have shown -- Paul Slovak is the person who has primarily done these studies -- is that nuclear power is placed at the very highest level, and risks like cigarette smoking and alcohol drinking are placed at the lowest, and I go to some pains to try to explain why I think that happens.

There is the greatest disparity between the actual health damage actually between nuclear power as the ultimate test of that theory, of that data. You could look at Paul Slovak's data, and there it is. It is very clear.

Q Would you think the Congress of the United States has a misconception of the risks of nuclear power?

A (WITNESS DUPONT) I don't know about that. I think there is a danger of an exaggeration of risk, about one kind of risk in relationship to another, and I think it is very important for anybody who is talking about health and effects on health to compare the risk that the population is enduring or experiencing from various sources, and one of the concerns I have about the general public reaction, including the reaction in the legislative and executive branches, is that I think a lot of times these risks are not compared, and that is one of the things that I recommend very much doing, is taking a look at where people are dying, what are they dying from, what are the preventable causes of death in the United States, and going about the serious business of reducing health dama--

I thi-- that there may very well be a problem.

Q And do you think that the insurance industry has a misperception of the risk of nuclear power, accidents from nuclear power plants?

A (WITNESS DUPONT) Again, about the insurance, I am a little -- I don't think that is an area of my expertise.

Q Well, let me ask you a hypothetical. If the insurance industry were to refuse to provide insurance to homeowner policies for nuclear accidents, would you consider them to have misperceived the risks?

A (WITNESS DUPONT) Well, let me make a distinction between property damage on the one hand and risks to health in terms of death on the other. I think the Three Mile Island accident is an excellent example, where there is a terrific disparity, where there was an enormous cost associated with that accident, but relatively good performance in terms of the protection of public safety.

And I think the insurance question you are talking about is not directly related to the public health question of life and death, but if it is, you can correct me. My understanding is that it isn't. It has to do with property damage, and the thrust of my testimony does not relate to property damage, but relates to health.

Q Well, considered in an individual or social institution evaluating risk, is loss of life the only factor in considering, or in reaching a conclusion as to risk?

A (WITNESS DUPONT) It is the one I am addressing in my testimony.

Q Would you think it is appropriate in determining whether or not there is an accurate assessment of risk, and that other factors besides loss of life should be taken into account?

A (WITNESS DUPONT) Sure.

Q Besides loss of life, what about suffering from radiation ailments? Would that be a factor?

A (WITNESS DUPONT) Yes, and I think that is a serious question. From my understanding, that has not happened to anybody in 25 years.

Q But in concluding that there is a misperception as to risk in your testimony, you are only addressing loss of life, the possibility of loss of life?

A (WITNESS DUPONT) I would include any radiation related health problem. I think the evidence is rather clear that in 25 years this has not happened. That is not to say it couldn't happen, but what I object to is, so much of this discussion is not portrayed to the public clearly, stating that this industry has in fact operated with a remarkable safety record in terms of protection of public health. I think that is a problem.

Q Well, again, I will pose a hypothetical. If Congress were to limit liability to a nuclear power plant operator for loss of life due to an accident at their power plant, would you think that that involves a misperception of risk?

A (WITNESS DUPONT) I really don't know. It is a hypothetical. It just frankly doesn't make very much sense to me.

Q Are you aware that the Price-Anderson Act does so limit liability for loss of life?

MR. COLARULLI: Your Honor, I object to these questions.

JUDGE GLEASON: He has indicated he is not an expert on Price-Anderson or insurance.

MR. HARTZMAN: Your Honor, it does go to the whole issue of whether or not there is a misperception in the public about risk of accidents at nuclear power plants.

JUDGE GLEASON: Well, it's got a very weak link to it, Mr. Hartzman, very weak. It is not as bad as the rattlesnakes, but --

(General laughter.)

BY MR. HARTZMAN: (Resuming)

Q Have you read the Indian Point Probabilistic Safety Study?

A (WITNESS DUPONT) No, I have not.

Q Have you read the Oak Ridge precursor study?

A (WITNESS DUPONT) No, I have not.

Q So you are not aware of what the evaluations of risks are at power plants or Indian Point in particular?

A (WITNESS DUPONT) I have read things like the emergency plan for Indian Point, for example. And I've read a number of studies about risk assessment. But I have not read those.

MR. HARTZMAN: I have no further questions.

JUDGE GLEASON: Mr. Kaplan, you don't have any questions, do you?

CROSS EXAMINATION ON BEHALF OF
NEW YORK CITY COUNCIL

BY MR. KAPLAN:

Q Dr. DuPont, we can go to something that you know about, Page 5 of your testimony.

JUDGE GLEASON: Mr. Kaplan, how much time will you need?

MR. KAPLAN: I really want to avoid answering that question. Ten or fifteen minutes, I hope. I would only say, Judge Gleason, I have been very quick. In the fact that I am coming at the end puts me under an inordinate amount of pressure. I know everyone wants to get away, but I have an obligation to my clients, and I apologize to all of you. I would like to leave as well.

MR. BRANDENBURG: I don't think you are coming at the end, Mr. Kaplan.

MR. KAPLAN: Well, the staff will have -- I am near the end.

MR. BRANDENBURG: I have cross examination, too.

JUDGE GLEASON: Go ahead, Mr. Kaplan.

BY MR. KAPLAN: (Resuming)

Q Let's try to focus on Page 5, where you introduce the notion of what-is and what-if. Is that terminology your own, sir?

A (WITNESS DUPONT) No, it is commonly used among people who treat phobic people.

Q Are there texts that have been written by other than yourself, if you have written one, or articles that use that terminology?

A (WITNESS DUPONT) Yes, there are.

Q Could you tell us who the authors of those texts are?

A (WITNESS DUPONT) Well, I think the primary author who uses these terms is Manuel Zane, who is the most prominent psychiatrist in treating phobias, and it is interesting to me that he is right here in White Plains, New York. This is the site of the first phobia treatment clinic in the country.

Q And it is interesting to me that he is not testifying for the Power Authority or Con Edison, if he is the authority.

A (WITNESS DUPONT) I think he would be willing to come.

Q I gather that the burden of your testimony is that the difficulty is not so much that people engage in what-is or what-if thinking, but that people who are engaging in what-if thinking don't perceive that they are doing that.

A (WITNESS DUPONT) That is correct.

Q And therefore it would not be irrational or phc'ic or an example of phobic thinking -- I don't want to get hung up in the distinction between phobic and phobic thinking. Phobic thinking, I guess, is clear. It would not be an example of phobic thinking for people to make decisions predicated upon what-if thinking if they understand that that is what they are doing?

A (WITNESS DUPONT) Sure.

Q Now, is the next piece -- we will play this out. The way I understand your testimony, it is that it is your judgment that too many of the people who are opposed to nuclear power, be they activists or just citizens --

A (WITNESS DUPONT) Not opposed to, fearful of.

Q Fearful. I am sorry. That are afraid of nuclear power --

A (WITNESS DUPONT) Yes.

Q -- do so, engage in what-if thinking though they believe they are engaging in what-is thinking?

A (WITNESS DUPONT) For example, they don't know that no one has been harmed in 25 years.

Q But we don't know --

A (WITNESS DUPONT) I think all the experts agree, to my knowledge. I don't think anybody says otherwise. In fact, your own witnesses here say that.

Q We can go into whether there have been deaths at nine commercial reactors.

A (WITNESS DUPONT) No, I am talking about commercial nuclear power. That is all I am talking about.

Q I understand, but there are other forms of nuclear power that are used.

A (WITNESS DUPONT) Of course.

Q And that those forms have in fact caused death. Isn't that correct?

A (WITNESS DUPONT) Well, as my 15-year-old daughter says, why don't they put it in bombs? It is obviously dangerous. I understand that.

Q So it is okay if the commercial people use it, because they know how to use it in a non-dangerous way, but governments or experimenters, they don't know how?

A (WITNESS DUPONT) So far, it is my understanding that there have not been injuries to public health because of commercial power plants. That is right.

Q And I don't think we are contesting that there have been injuries. The question I am asking is -- going back to where we were, the problem is, as I said before, I think you agree that the relationship between -- people are engaged in what-if when they think they are doing what-is?

A (WITNESS DUPONT) Right.

Q Now, of those people afraid or who have a fear of nuclear reactors, how many of those, if you can give me a percent, do you believe are suffering or are victimized by phobic thinking? And if you could offer me a percentage, could you give me the basis of that judgment?

A (WITNESS DUPONT) Well, the kind of thing that I am concerned about is surveys that show that about half of the American public believe that nuclear power plants can blow up like a bomb, with a plume cloud and all that kind of thing. That is the kind of concern that I have. That is not possible. And to have people understand that it is not possible to have that kind of an explosion of a commercial nuclear power plant, it is important for people to understand.

Q But are you suggesting that -- Well, let me ask the question again. I don't think that was responsive. It is your testimony and what you have just said is that 50 percent of the people who are afraid of nuclear power are victims of phobic thinking, or think phobically.

A (WITNESS DUPONT) I wouldn't want to put percentage numbers on it, because it is not based on a study that has been done.

Q You just said that 50 percent --

A (WITNESS DUPONT) Of the total public.

Q Fifty percent of the total public?

A (WITNESS DUPONT) That's right. Believe that nuclear power plants can blow up like a bomb.

Q But we don't know how many of those people have any fear of nuclear power.

A (WITNESS DUPONT) I think it would be fair to estimate that a large percentage would be.

Q But you have no clinical basis to make that estimate?

A (WITNESS DUPONT) No, that's right, to put a number on it.

Q It is not phobic, it is not an example of phobic thinking to be at risk?

A (WITNESS DUPONT) Sure.

Q If we know that there is in fact a possibility of some danger?

A (WITNESS DUPONT) Right.

Q Would, however, a manifestation of phobic thinking be a overreaction, an overkill to some small nuisance, hypothetically? I don't know, maybe you can give me an example.

A (WITNESS DUPONT) A fear of cockroaches, for example. You know, to not go into a house.

Q Or to tear a building down if you saw a cockroach.

A (WITNESS DUPONT) Yes, that kind of thing.

Q In some sense, then, the emergency planning efforts, since there have been no deaths from nuclear reactors, would you characterize that as a phobic response, given the lack of any accidents that have caused serious injury?

A (WITNESS DUPONT) No, I would say the efforts that have been made by the public to make this technology safe have been largely successful in making it safe, and that they ought to be credited as such.

Q If I may, I am talking about the function of the emergency planning aspects alone.

A (WITNESS DUPONT) Including the emergency planning.

Q In 1979, 1977, 1978, when the first post-TMI -- went into effect, the emphasis on emergency planning -- prior to that, there had been no deaths, had there?

A (WITNESS DUPONT) No, there hadn't been.

Q So prior to that, it would have been phobic to do planning for accidents?

A (WITNESS DUPONT) No, because there is a possibility. You plan for that, so it is perfectly reasonable.

Q And the possibility often can be predicated upon looking at what the worst case might be?

A (WITNESS DUPONT) Sure.

Q And trying to limit that?

A (WITNESS DUPONT) Exactly.

Q And it is a mini-max thinking, so to speak, if you are familiar with that term. It is not phobic?

A (WITNESS DUPONT) That's right.

Q And in your estimation, it is appropriate when looking at these kinds of situations?

A (WITNESS DUPONT) Exactly. It is like putting on a seatbelt in a car. I think that is a very practical thing to do.

Q Prepare yourself for the worst case?

A (WITNESS DUPONT) Sure. You could have an accident.

Q If we could go to Page 9, you make some judgments there about people's responses, people dealing with emergencies. The burden of that piece of your testimony is basically that those people, even those who are victims of phobic thinking, will in all probability behave in a rational, reasonable, controlled manner when confronted with an emergency. Is that correct?

A (WITNESS DUPONT) That is correct.

Q Are you familiar with the New York City blackout of 1977?

A (WITNESS DUPONT) Yes, I am.

Q And would you describe the behavior of at least some percentage of the population in that as comporting with your judgment about how people would respond in the event of an emergency?

A (WITNESS DUPONT) There were some very negative events during that emergency. Exactly. I was a participant in an earlier blackout in Boston.

Q In '66 or so?

A (WITNESS DUPONT) Yes, I think it was. And it was a much more scarey situation because it had never happened before, and there were no such incidents then.

Again, let me say that I would not say that there would never be an incident that everybody would in all circumstances behave in an exemplary way. What I am saying, though, and I believe this was also true in the New York situation, is that a very large percentage of the public did behave in a very responsible way.

Q Would you agree that a tremendous amount of havoc could be created by a small number of people, be they phobic or not, but people who don't behave?

A (WITNESS DUPONT) That is a good point. I don't think the people who were doing the looting were phobic.

(Laughter.)

Q That's right. Therefore, if we are projecting behavior, the burden of your testimony says, here's how phobic people will behave?

A (WITNESS DUPONT) Yes.

Q But that really, then, from what you have said, isn't a predictor about how anyone in the general population would behave.

A (WITNESS DUPONT) Well, I think there's a lot of experience in emergencies about how people do behave in emergencies, and I think the summary of that by any fair review is that people behave quite responsible.

Q But even if we were to say that 90 percent of the population would behave, that 10 percent could, I would think from your agreement, could cause tremendous amounts of havoc and in fact totally swamp, not necessarily by numbers but by effect, the appropriate behavior of the others.

A (WITNESS DUPONT) Mr. Kaplan, from my point of view you are now engaging in a what-if discussion.

Q Absolutely.

A (WITNESS DUPONT) Let us talk about what has actually happened in real emergencies.

Q I'm talking about New York City in 1977.

A (WITNESS DUPONT) No, you are isolating one example and taking it out of context of the general experience, and then you are treating it as if that is what is to be expected.

What I am saying, sir, is that if you will look at the general experience in the context of the behavior of people in real emergencies in this country, and for that matter abroad, what you will find is not examples of social disorganization and great danger because of this, but in fact the opposite: pulling together in the population, and not the opposite.

Q Didn't you just say to me a few moments ago that it's rational and reasonable to prepare for worst cases? Didn't you say that a few minutes ago? Can you answer that yes or no?

A (WITNESS DUPONT) Yes.

Q Then wouldn't it be rational and reasonable to prepare for the worst kind of a case of social emergency?

A (WITNESS DUPONT) It depends on what the costs of that are, but I think basically there's something to be said for it.

Q Now we're talking about costs. So let's move on a little bit. That's another point somewhere in here.

Let me go to a different point. On page 19 -- I realize I'm jumping around -- you talk about what a leader should be, that our leaders should be "what-is thinkers." And by the way, let me ask you a question on this. What is to "what if"?

Are these totally different characters or really are they ends of a continuum? I mean, are they really different things in terms of quality or is this sort of a quantitative line that people vacillate on and that you could move down, that you could move down the road?

A (WITNESS DUPONT) Well, "what-if thinking" from my point of view, the way I use the term, is not just projecting yourself into the future and assessing risks from that projection. But it involves a single focus on what you are calling a worst case, some kind of disaster scenario, and treating that as if that is all there is.

It is what happens to a person who has a fear of flying when he is stepping on the airplane. He doesn't have a sense of what the airplane or that plane is. What he perceives is that the risk begins with --

Q Well, let me see if I understand this and use the example on sort of a macro scale. The United States does a budget?

A (WITNESS DUPONT) Yes.

Q And we have a domestic budget and a foreign policy budget. And we have never been bombed, I think we all agree, by the Soviet Union. We have not yet experienced anything -- any attack by the Soviet Union, although we're putting thousands of millions of dollars into that, and some would argue ignoring the risks of social disorder, health benefits, health problems.

In your analysis, in your framework, is that an analogous situation? Too much focus on one problem, not enough on another, misperceiving the risks, especially when there's never been, in the 50 years, even more, since 1918 -- is that the kind of thinking that you're talking about?

A (WITNESS DUPONT) I don't perceive that as a similar kind of issue.

Q The scale is different, but isn't it from your analysis the same?

A (WITNESS DUPONT) I think there is a fundamental leap that you're making that I cannot make with you, and that is that, if I understand the thrust of your question, it is if something has not happened or has a low probability of happening, then one should not be concerned about it. You are attributing that thought to me, and then you're trying to -- what I am saying is that low probability risks are perfectly reasonable to be concerned about.

At no point did I say that you ought not to be concerned about something that has a low probability of risk. In fact, as you say, the threat of war is a threat that is of major concern and is perfectly reasonable to be concerned about. So that is not what I'm saying.

Q Is it the question of the various levels of response to those risks? Theoretically, I would assume that you would argue that we should respond more assiduously, more affirmatively, with more resources, more effort, to those risks which are more likely than to those which are less likely, correct?

A (WITNESS DUPONT) Yes, that's part of it.

Q And that one of the ways we look at likelihood is by looking at past experience; is that correct?

A (WITNESS DUPONT) That is correct.

JUDGE GLEASON: Are you getting lost, Mr. Kaplan?

MR. KAPLAN: No, I'm not getting lost at all, and I'm sure when we all read the record you'll see that I haven't been lost.

BY MR. KAPLAN: (Resuming)

Q In that case, taking the risk of war with the Soviet Union, given the likelihood of giving it a low level of risk, given the fact that it hasn't happened in the past, using your categories isn't it phobic to apply a massive amount of resources to deal with that risk to the detriment of dealing with other dangers?

A (WITNESS DUPONT) I don't think so, because the assumption, anyhow, on which to my understanding of our defense expenditures are based has to do with the concept of deterrence, that if we were to reduce the expenditures we would increase the probability of having a serious problem.

So I don't see that that makes sense.

(Pause.)

Q Let me ask another question. Somewhere in your testimony you suggest that it's -- or you don't suggest; you do it very particularly. Very specifically, you talk about public interest folk who are going out, I guess in your terminology, pandering and playing on fears, is that right? I think it's on the bottom of page 14.

A (WITNESS DUPONT) Right.

Q And you are suggesting somehow, am I correct, that this effort is misdirected?

A (WITNESS DUPONT) Yes, that's right.

Q Have you ever --

A (WITNESS DUPONT) I was referring to a pamphlet or two pamphlets, I guess, that I had reviewed earlier.

Q So that is the only evidence you have of the effort? That is the only evidence upon which you make that judgment; is that correct?

A (WITNESS DUPONT) That is the basis of this statement here, yes.

Q Since history seems to be a basis upon which we can judge the likelihood of an event that we may or may not be afraid of, how many occurrences -- and maybe you can't quantify it -- or how many near-misses would there have to be before someone you would label engages in "what-if thinking" would become someone who, not by any change in their thinking, is vindicated, so to speak, by the occurrences?

Do you understand my question? You can answer it, please.

JUDGE GLEASON: Do you understand the question?

WITNESS DUPONT: No, I can't.

JUDGE GLEASON: Nor can I.

BY MR. KAPLAN: (Resuming)

Q Hypothetically, if there were a nuclear accident all of those people who you are prepared to label "what-if thinkers" because they are afraid of nuclear power and you think unrealistically or irrationally -- would the event change your judgment about their thinking?

A (WITNESS DUPONT) Would what event?

Q A nuclear accident in which 1,000 or 2,000 or 500 or 4 people were killed.

A (WITNESS DUPONT) Yes. You'd have to put that in context with what the overall risk was, I think that is right.

Q So that an event would change?

A (WITNESS DUPONT) Of course.

Q So in other words, it's like I told you so.

A (WITNESS DUPONT) But that is like all the other risks that we're talking about. Of course it's based on experience.

Q So then if that is the case, it is not so much the manifestation of a point of view, but what you are really going to is the motive for the point of view; is that correct?

A (WITNESS DUPONT) I don't know the motive. I think perspective is what my concern is. You know, it's like when you talk to someone about fear of flying, you can't really say to them flying is safe in an absolute sense. There are people who have died as a result of this.

You're acting as if I'm saying that nuclear power is absolutely safe under any circumstances and anyone who has any concern about it is crazy. I am not saying that, so I don't know what the thrust of your question is.

I agree that there is reason to be concerned and I think that the concerns are well placed, and I think that they have been effective. I am just saying, let's put that in perspective of what the actual experience is and let's make sure that the public as well as the policymakers understand what has actually been the record in terms of public health.

That is all I am saying, not that it couldn't be dangerous. I understand that it could be.

Q I'm really talking about the burden of your testimony on individual people. We all agree and there's not much difference in this room about your statement. The question I think is a disagreement on the nature of the risk and whether or not it is prudent.

I'll withdraw it.

MR. KAPLAN: I think I'm almost finished.

JUDGE GLEASON: Did you say you're finished?

MR. KAPLAN: Almost.

JUDGE SHON: Almost.

BY MR. KAPLAN: (Resuming)

Q One other thing. In terms of the response, you would agree with me that we really don't know with any certainty whether or not there have been long-term chronic effects that may result from the operation of nuclear power? You don't know that, do you?

A (WITNESS DUPONT) Well, I know the Three Mile Island Commission looked at that question very carefully and projected out, in what I thought was a rather conservative series of assumptions, that there would be an increase of six-tenths of one person increased cancer deaths in the course of the live of the people who lived within, I don't remember what it was, 20 miles of TMI.

Q Yesterday morning we heard testimony from other doctors who took the position that there was no way to know about the long-term effects of exposure to even minimal radiation above background levels. Would you disagree with that?

A (WITNESS DUPONT) I think the argument that one doesn't know all the answers is pretty --

Q No, I am asking you, sir, if you agree with what I just said or disagree. Do you agree with what I just said or not?

A (WITNESS DUPONT) I guess I agree with that, yes.

Q Now, would it be phobic to -- withdrawn.

Fears, then, that stem from those long-term impacts would not be irrational; is that correct?

A (WITNESS DUPONT) That is right.

Q And therefore behavior that is generated out of that rational fear would also be appropriate?

A (WITNESS DUPONT) Sure.

Q You have a quarrel on page 14 with the media. Is it your position that the media should not cover statements that are not balanced in your definition?

A (WITNESS DUPONT) I think the media bear an awful responsibility for an exaggeration in the public mind of where the risks to health really lie, in that what they do -- they are like moths drawn to a light, because of the psychology of perception of risk, and that when they get a single big event or the threat of an event they exaggerate it. And when they get things that are spread out -- you talk about cancer deaths, for example. Where is the concern about the many thousand cancer deaths a year from cigarette smoking?

Q I think if you read the media there is a lot of --

A (WITNESS DUPONT) Very little with the concerns that we're talking about.

Q Let me ask you, do you think it's also inappropriate for Licensees to use access to the media, then, to maybe create misperceptions as well?

A (WITNESS DUPONT) No, I don't think that is a good idea.

Q You don't think anyone should create misperceptions?

A (WITNESS DUPONT) No.

Q So now, as long as we're talking about misperceptions, reasonable people can differ on that?

A (WITNESS DUPONT) Sure.

Q Would you agree that repetition of a message imprints learning?

A (WITNESS DUPONT) Sure.

Q So therefore, for argument's sake, if a lot of commercials were to be run by Licensees or by anybody, that that would create what may be a false impression, merely by the repetition of the message?

A (WITNESS DUPONT) That could be.

Q You would then oppose people who abuse access to the media to repeat a message that would be false or erroneous?

A (WITNESS DUPONT) That is correct.

Q You also agree, by the way, that alerting someone to something you believe is a danger, though it may generate fear, would be a good thing to do?

A (WITNESS DUPONT) Exactly.

Q In fact, as a doctor you would have an obligation to alert people to danger, no matter how remote it might be?

A (WITNESS DUPONT) As long as it is in perspective, I think that's right.

Q And since "perspective" is a relative term, people can differ on perspective?

A (WITNESS DUPONT) You talk about evacuation plans, for example. Let's tell people what --

Q Please answer my question. Reasonable people can differ on -- "perspective" is a relative term and reasonable people can differ on that; is that correct?

A (WITNESS DUPONT) Yes.

(Pause.)

Q Have you read the paper this morning regarding statements made by the Governor of your State?

A (WITNESS DUPONT) Yes, I have.

Q And what occurred in Suffolk County yesterday?

A (WITNESS I didn't read that.

Q Suffolk County said that there was no such thing as a workable escape evacuation plan for Suffolk County.

Would you characterize the legislators and the Governor as "what-if" thinkers?

A (WITNESS DUPONT) My reading of the paper was that there's going to be some more thinking about that to be done, and I think that my reading of it seems like there is more thinking to be done. I'm all for that.

Q Mr. Kohalan said it was his belief, his position -- he's the County Executive -- that no plan is possible. Is that "what-if" thinking?

A (WITNESS DUPONT) I wouldn't comment on that particular plan.

JUDGE GLEASON: Mr. Kaplan, let's wind up your cross-examination, please.

BY MR. KAPLAN: (Resuming)

Q You characterize people involved in nuclear planning as, I think the term on page 20, "'good,' well-trained and unafraid." I mean, you put "good" in quotation marks. Does that mean they don't beat their wives or spouses? What do you mean by "good"?

A (WITNESS DUPONT) That the people I talked to, anyhow, appeared to be pretty sensible.

Q You didn't examine them clinically?

A (WITNESS DUPONT) No, no, no. This was just a visit, and talking with people at other plants.

Q So they didn't drool or have whips or things like that? It was a very lay kind of judgment.

(Pause.)

MR. KAPLAN: I think I only have one more.

I have no further questions.

JUDGE GLEASON: Does the Staff have any cross?

MR. BRANDENBURG: I have a couple of questions, Mr. Chairman.

JUDGE GLEASON: I asked the Staff.

MR. McGURREN: Yes, Your Honor, the Staff has just a couple of questions.

CROSS-EXAMINATION ON BEHALF

OF THE REGULATORY STAFF

BY MR. McGURREN:

Q Dr. Dupont, would you please turn to page 9 of your testimony.

A (WITNESS DUPONT) Yes.

Q About seven lines down, you state that, "Experience has taught us that when dealing with emergencies people behave competently, responsibly and sensibly."

A (WITNESS DUPONT) Yes.

Q Can you indicate to me what experience you're making reference to there?

A (WITNESS DUPONT) Well, I can describe my own experience involved in the evacuation from Hurricane Agnes when myself and my family were evacuated, but also from rather considerable experience with others who have been -- worked more with this area, including people from the Federal Emergency Management Administration, a scientist named George Worheit whom I worked with on an NRC panel on this subject. And my understanding is that is a pretty commonly accepted point of view among people who have worked in disaster situations, both natural and manmade.

Q Any other instances beside the hurricane experience that you had?

A (WITNESS DUPONT) No. My own experiences have been limited to that. I was involved in a tornado at one point as a child and other situations, and again that's my personal experience.

The snowstorm last week in Washington was quite disruptive on many people. A patient of mine, for example, spent seven hours getting home and had to spend the night with strangers, and this was stressful to him. But he found people behaved very reasonably.

Q And when you say people -- and I see you use the term "people" in your testimony -- are you referring to just those that would be evacuated or are you also making reference to like firemen and police?

A (WITNESS DUPONT) I think --

Q Let me finish.

-- and police and other people that might be assisting in an emergency?

A (WITNESS DUPONT) I definitely am including them.

Q And would you please turn to page 22 of your testimony. Close to the middle of the page, starting with the sentence "Despite," you go on to say, "I believe that during such an evacuation people would behave responsible and competently."

I ask you again the same question. In your use of the word "people," are you referring to those who might be involved in assisting in an emergency situation?

A (WITNESS DUPONT) Yes, and I would be going beyond that. I would expect the people who are assisting to behave at an even higher level of performance. But that definitely is included in the statement.

Q Why would they behave at a higher level?

A (WITNESS DUPONT) Because I think most people, medical people, firemen, police and all, are really very dedicated to their public service motives, and when called on in an emergency will rise to very extraordinary levels of dedication in the performance of their duties.

MR. McGURREN: Thank you, Your Honor.

JUDGE GLEASON: Mr. Brandenburg?

REDIRECT EXAMINATION ON BEHALF
OF LICENSEE CONSOLIDATED EDISON

BY MR. BRANDENBURG:

Q Dr. Dupont, Mr. Kaplan was asking you a number of questions about the relationship between the phobic thinking referred to in your testimony and emergency planning and so on. My question is, is it in your expert judgment likely that the fact that comprehensive emergency planning in the vicinity of nuclear power plants, with distributions of booklets and posters in public parks and things of that sort, has itself increased the incidence of public thinking in a phobic way about commercial nuclear power plants?

A (WITNESS DUPONT) I think it could. There's a paradox with that, because without empirical testing I think you can make a case for going either direction. But I think for many people who operate by -- who fear less by denial, that the active involvement of a plan would get them to reduce their denial, it would make them more fearful.

On the other hand, at least some people who are already fearful would find it reassuring that there was a plan. So I think we've got trends going in both directions. What the net effect would be I would not want to predict.

Q Do you perceive a trend one way or the other based upon the comprehensive radiological emergency planning that has occurred to date?

MR. KAPLAN: Objection. Asked and answered. He just answered the question.

JUDGE GLEASON: Answer the question, please.

More people object, Mr. Kaplan.

WITNESS DUPONT: Restate the question? I'm sorry, Mr. Brandenburg.

BY MR. BRANDENBURG: (Resuming)

Q You in your last answer identified sort of crosscurrents of response, and I'm just wondering, based upon the level of publicity about emergency planning, with all the implications that you described in your past answer, to date the various plans with the booklets and posters and so on, whether you feel -- whether you see a trend one way or the other based on the crosscurrents?

A (WITNESS DUPONT) I think in general there is a lessening of fear, would be my assessment. I think that the TMI accident would be the peak and I think there has been a falling off since then.

Q Now, as your opening statement recognized, your testimony is being received into this hearing for purposes of its relationship to emergency planning, which is somewhat of a different thrust than was originally intended.

And my question along those lines is whether it is your expert that the widespread presence of phobic thinking relative to commercial and nuclear power would likely enhance or detract from the ability of the general population to carry out an effective evacuation from the vicinity of a nuclear power plant?

A (WITNESS DUPONT) I would not think it would detract from it, I don't think so, not at all. I think that people would be at least as prepared to do it -- I'm not saying they would be better -- in the face of that fear. The fear has a way of mobilizing interest and getting people's attention, and that is not a bad thing in an emergency situation.

Q Well, if we take the general population around a nuclear plant, we have, as I understand your testimony, a portion of them that are undergoing some phobic thinking on this topic, and we have that as our group we're looking at and the non-phobic thinkers in this area are the control group or something.

A (WITNESS DUPONT) Right.

Q And there were to be an evacuation.

A (WITNESS DUPONT) Yes.

Q Would you expect that the group of the phobic thinkers would be able to respond to the evacuation in a more effective manner than the ones that were not subject to this type of thinking?

A (WITNESS DUPONT) I don't think necessarily more effective, but I think they would be as effective in their response.

MR. BRANDENBURG: That is all the questions I have.

JUDGE PARIS: Dr. Dupont, looking at your biographical sketch I see that you have apparently been interested in the phobic fear of nuclear power for some years, and I would just like to ask how you became interested.

WITNESS DUPONT: I was recruited by the Media Institute to study television coverage of nuclear power in 1980 following the TMI accident, and they recruited me specifically because I had no position or axe to grind or whatever else about nuclear power at all. And essentially the study I did involved reviewing all the television news shows about nuclear power for just about 11 years, '68 to '79, and then writing a report about what I saw in that. And that was my initiation to this field.

JUDGE PARIS: I see. Thank you.

JUDGE GLEASON: Mr. Colarulli, do you have any redirect?

MR. COLARULLI: No redirect.

JUDGE GLEASON: Doctor, we appreciate having your testimony. You are excused. Thank you.

(Witness excused.)

JUDGE GLEASON: We have two remaining items here, which should be very brief. Mr. Kaplan, you have two requests in here for subpoenas, and I thought I understood you to say yesterday one of them has been cancelled because you have Mr. Littlejohn's testimony.

MR. KAPLAN: No, no, no, no, no, no, no. Let me be clear.

There are two. There are two people, Robert Littlejohn, the Director of Emergency Planning, and Benjamin Ward, the New York City Commissioner of Corrections. Mr. Ward has prefiled testimony and has requested he be served with a subpoena so that he will appear. He will not appear without it. That what he's asked for.

Mr. Littlejohn has been spoken to and has not prefiled testimony, has declined to prefile testimony. Yet, if you look at his job, which is the Director of Emergency Planning for the City of New York, I have no doubt that the Board would find what he has to say not only relevant but almost crucial when one is considering the response of New York City to an emergency.

JUDGE GLEASON: What is the relevance of the testimony of the Department of Corrections?

MR. KAPLAN: Mr. Ward will testify to the evacuation transportation capability and emergency response capability of the Department of Corrections.

That is all he will talk about.

JUDGE GLEASON: We'll have to issue your subpoenas when we get back.

MR. LEVIN: I could not hear what you said.

JUDGE GLEASON: I said we will issue the subpoenas when we get back and send them to him to service.

MR. LEVIN: It would seem to me, Your Honor, that at least the latter subpoena would relate very directly to the Power Authority and Con Edison's motions with respect to the limitations to be placed on the New York City Council testimony. For example, if what the Department of Corrections witnesses testified to relates to evacuation, it would not be material to this proceeding, if you accepted our position.

JUDGE GLEASON: I understand. I am glad you brought that up, because you do have a pending motion on that testimony. When should we argue that thing?

MR. KAPLAN: I can't hear you. I am sorry.

JUDGE GLEASON: I indicated that I was glad he brought that up, because it recalled to me that we have a pending motion with respect to striking that testimony, and I presume we are going to argue that now, or should we wait?

MR. LEVIN: I think we need to deal with it now, Your Honor, because we have to make plans for the week of the 1st.

JUDGE GLEASON: Do you want to make your argument on the motion?

MR. BRANDENBURG: We filed separate motions, Mr. Chairman. I will be quite brief. Our review, which has been quite careful, of the testimony that has been proferred by Mr. Kaplan indicates to us that the great bulk of the testimony relates to the feasibility of evacuation from the City of New York.

Now, this is again not a matter on which we write on a clean slate in this proceeding. It was an issue before the Commission back in July, and on their July 27th order they had given all of us very explicit guidance on this.

This arose from the standpoint of the normal 10 CFR provision precluding challenges to Commission regulations. Back in July, we had a number of issues in the case that discussed the subject of evacuation outside the ten-mile zone, and the Commission states, and I refer you to it, on Page 14 and 15 of their order in particular, that there was no intention to except 10 CFR Part 758 from applicability in this proceeding, and that in fact the Commission's orders establishing this proceeding did not contemplate a challenge to the Commission's regulations.

And then they went on to quote the provision about how the EPZ from plume exposure pathway, which is the only one that involves emergency planning, or, excuse me, comprehensive evacuation planning, was to consist of an area of about ten miles.

Now, Mr. Kaplan's testimony or, more correctly, the testimony of his witnesses ignores that provision of the Commission regulations, and ignores that provision of the Commission's July 27th order in this proceeding. And the teeth of that order goes on to discuss at great length the feasibility or lack of feasibility of evacuating New York City.

We think it is crystal clear, both from the generic standpoint of 10 CFR 2.758 that if there was any uncertainty there, certainly as clarified by the Commission's order of July 27th, that that topic is simply not one for this proceeding. We do not seek to have all of Mr. Kaplan's clients' testimony excluded, but clearly the great bulk of it, which discusses the feasibility of evacuation from New York City, falls within that category, and we do not believe it is properly cognizable in this proceeding.

MR. LEVIN: It is all in our memo, Your Honor. We have nothing to add.

JUDGE GLEASON: Mr. Kaplan?

MR. KAPLAN: Just for the record, the response to that motion is in the mail.

JUDGE GLEASON: It is in the mail?

MR. KAPLAN: Yes.

JUDGE GLEASON: We have already decided we will not decide it until we get back, so we will wait until we hear from you.

MR. KAPLAN: I would like to say, however --

JUDGE GLEASON: Something that is not in --

MR. KAPLAN: Part of the difficulty of responding to both motions was that they were made so generally and at such a late date, and I did not argue this, but it should be clear that when they attack as to all the witnesses, and then you have a concession that some of them are okay, it makes a response very difficult. The response is as general as the attack, which is a general opposition. It is admitted necessarily by the letter I gave the Board today and a number of the parties, which indicates which witnesses have been formally withdrawn and which remain.

The way the Board has dealt with these situations over the last number of weeks is that at the time the witnesses are called, the arguments have been made and I would ask that that is exactly what happens here, to allow a face to face, so to speak, and a discussion around specific witnesses at issue.

JUDGE GLEASON: Well, the testimony has been filed. Pardon?

MR. BRANDENBURG: Mr. Chairman, I would like to oppose the latter suggestion of Mr. Kaplan. We had Dr. Cohen, who sat here for three days, and his testimony was ultimately excluded, and that worked a hardship to him. I think we did make these motions timely, and I don't believe waiting until the day of March 1st serves the purposes of this.

MR. KAPLAN: I would only say, on the question of timeliness, they have had the testimony since July 23rd, and they made the motions last week.

JUDGE GLEASON: Mr. Kaplan, I do believe we will want to act on this next week, just because if we have the arguments there, we should do it. And that is what we will do.

Now, let me go a moment to your schedule here.

MR. KAPLAN: Well, I don't know how relevant it is, depending on how the Board --

JUDGE GLEASON: I understand that, but assuming, assuming that these witnesses would be permitted to testify, let's go to your schedule. All right?

JUDGE PARIS: It is a hypothetical.

MR. KAPLAN: The question is, what is the probability curve?

JUDGE GLEASON: I am not able to evaluate how much testimony these people have. I am certainly not, therefore, able to give any kind of evaluation to the amount of time that cross examination might transpire. It does seem to me that you are stretching out here to four days something that should be done in two in any event.

MR. KAPLAN: I have tried to do that --

JUDGE GLEASON: Well, I am just going to suggest to you that you get at least your limited appearances on Friday and put them either on Tuesday or Wednesday.

MR. KAPLAN: Those are New York State legislators. They will not be in New York City.

JUDGE GLEASON: All I am saying to you is, if we have concluded all of the testimony we are going to receive by the end of Wednesday, March the 2nd, and there are no other requests available to the public for limited appearances, we will not go to Thursday and Friday.

MR. KAPLAN: I understand. What we have been talking about, and we have had off the record snippets of these discussions, and I thought you had been aware of these snippets of discussions -- if you are not, there was some discussion between the intervenors and the licensees about filling the rest of the time in order to take the pressure off this whole emergency planning sequence.

MR. LEVIN: Your Honor, if I might, everyone in principle agrees that if there is some time available during that week, that it might be useful to put some emergency planning witnesses on.

JUDGE GLEASON: I see. I have not been privy to what has come out of that. If that is the case, that is fine, but I just can't have the Board sitting around.

MR. KAPLAN: We understood, Judge. We had that discussion with you. We had it with Ms. Miller. And I apologize, but I thought we even mentioned it yesterday to you, that the licensees were considering this.

JUDGE GLEASON: Well, I remember it being mentioned, and nobody has come to me with that thing. And the Board has the responsibility of setting schedules. We do that based on what of substance is going to be testified.

MR. KAPLAN: I really say I have no doubt the licensees and intervenors have an agreement in principle that we will have enough witnesses to fill those four days plus another ten to fifteen.

JUDGE PARIS: All right. Let's see your

proposed schedule.

MR. LEVIN: That's right, but we don't at this moment, and we won't until the first of next week.

MR. HOLT: Mr. Gleason --

JUDGE GLEASON: Excuse me just a minute. I think there is another complication. We just appointed an alternate Board member to review testimony under these questions.

MR. LEVIN: Obviously, Your Honor, any witnesses who appeared would have to be witnesses about whom there was no doubt with respect to whether they ought to be or not.

MR. HOLT: Mr. Gleason, we have agreed amongst us, and I was prepared to announce this at this time, that we have agreed in principle, all of us, that we would use whatever time is available for witnesses, as Mr. Levin has just told you, and we have also agreed that we would use the weekend to find out which of our witnesses are available, and we will consult amongst the parties early in the week and let you know as soon as we decide which witnesses we have agreed to line up and have ready.

MR. BRANDENBURG: Mr. Chairman, I am not privy to such --

JUDGE GLEASON: Well, you people agree to agree or disagree, but make sure you advise us by the middle of the week.

MR. KAPLAN: If I may say one further thing about a question that was passed over, my motion papers dealt with -- my papers in response to the motions made for licensees dealt with testimony that had been admitted up to the time I wrote them, and they took a while to get out since I have been here.

I would point out that testimony today, the notion of the relocation mode raises the same questions that the evacuation question does and New York City's capability, and I would just ask the Board to keep that in mind. We are talking about moving people under the relocation model which postures and posits the necessity to move populations in the New York City area.

JUDGE GLEASON: Well, I can't relate to what they said to that issue, so let's conclude. We have now concluded, except for the two witnesses, the staff's testimony on Question 1.

MS. MOORE: Your Honor, may I interject here? That is not quite correct. There is, if you remember, a witness scheduled to come up and speak on a very particular subject which goes to Question 1 concerning source terms.

JUDGE GLEASON: And there is an additional witness, as you will recall.

Thank you very much. We will see you in New York City, maybe.

(Whereupon, at 2:42 p.m., the Board was recessed, to reconvene on Tuesday, March 1, 1983.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

ATOMIC SAFETY AND LICENSING BOARD

in the matter of: CONSOLIDATED EDISON COMPANY OF NEW YORK (Indian Point Unit 2) POWER AUTHORITY OF THE STATE OF NEW YORK (Indian Point Unit 3)

Date of Proceeding: February 18, 1983

Docket Number: 50-247 SP & 50-286 SP

Place of Proceeding: White Plains, New York

were held as herein appears, and that this is the Original transcript thereto for the file of the Commission.

Alfred H. Ward

Official Reporter (Typed)

[signature]

Official Reporter (Signature)