OFFICIAL TRANSCRIPT
PROCEEDINGS BEFORE

THE ATOMIC SAFETY AND LICENSING BOARD

NUCLEAR REGULATORY COMMISSION

DKT/CASE NO.	50-454 OL & 50-455 OL
TITLE	COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station 1) COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station Unit 2)
PLACE	Rockford, Illinois
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	Docket Nos.:
COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station Unit 1)	50-454 OL
COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station Unit 2)	50-455 OL

United States District Courthouse
211 South Court Street
Rockford, Illinois

March 15, 1983

The hearing in the above-entitled matter convened, pursuant to notice, at 9:00 A. M.

BEFORE:

IVAN W. SMITH,
Administrative Judge

A. DIXON CALLIHAN,
Administrative Judge

RICHARD F. COLE,
Administrative Judge

APPEARANCES:

On behalf of Licensee, Commonwealth Edison Company:

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BRYAN SAVAGE, Esq.
DAVID THOMAS, Esq.
STANLEY CAMPBELL
DIANE CHAVEZ
BETTY JOHNSON

C O N T E N T S

RECESSES:

Morning - 1977
Afternoon - 2086

JUDGE SMITH: Good morning.

Is there any preliminary business?

(No response.)

JUDGE SMITH: I note that we received our in camera testimony on the sabotage issue; but I don't believe we provided for execution of contracts for the non-lawyers who were present. I mean, that would be Mr. Campbell and Mrs. Johnson.

I got the impression that the Applicant was going to take care of that, although I don't know if it was expressly understood.

MR. RAWSON: Judge Smith, I don't believe we had addressed the question of who specifically would be preparing non-disclosure documents.

JUDGE SMITH: I suggest that -- we have the in camera testimony here. We will give Mrs. Johnson and Mr. Campbell an opportunity to read it and sign it. That seems to be a shortcut way to accomplish the same thing.

They did agree orally during the in camera testimony to hold the information confidential.

Whatever the parties wish. I just want to point out that it is an open item of business.

That is just as a proposal. We will come back to it later.

Mr. Gallo.

MR. GALLO: Thank you, Judge Smith.

At this time I would like to call as my witness, in connection with three contentions, League of Women Voters 8 and 62 and DAARE/SAFE Contention 2a -- I would like to call Mr. Levine to the stand.

(Witness sworn.)

JUDGE SMITH: Before Mr. Levine starts to testify, the record should reflect that Mr. Levine was a member of the NRC staff. He lectured the members of the Atomic Safety and Licensing Board panel during an annual training meeting on the event tree and fault tree methodologies.

I was present.

Dr. Cole, were you?

JUDGE COLE: Yes.

JUDGE SMITH: Dr. Callihan wasn't present.

I say with varying degrees of comprehension.

SAUL LEVINE

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

DIRECT EXAMINATION

BY MR. GALLO

Q Mr. Levine, would you state your full name and occupation for the record, please?

A My name is Saul Levine. I am Vice President and Group Executive of the consulting group of NUS Corporation.

Q Mr. Levine, have you prepared testimony for this proceeding in connection with Contentions 8, 62 and 2a?

A Yes, I have.

Q I show you a document entitled, "Testimony of Saul Levine," consisting of approximately 35 pages, and ask you if this is the testimony that you prepared for this proceeding?

A Yes, it is.

Q Is it accurate and correct, to the best of your knowledge and belief?

A Yes, as far as I know.

Q Well, did you check it to determine whether or not it was?

A Yes, I did.

Q Thank you.

If you were asked to testify orally here today, is this the testimony you would give?

A Yes, it is.

MR. GALLO: At this time, Mr. Chairman, I would like to offer the testimony of Mr. Saul Levine into evidence and enfold it into the testimony transcript as if read.

MR. THOMAS: No objection.

MR. RAWSON: No objection.

JUDGE SMITH: The testimony is received.

(The document referred to, the prepared testimony of Saul Levine, received in evidence, follows:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket No. 50-454-OLA
	)	50-455-OLA
(Byron Station, Units 1 and 2)	)	

COVER SHEET

The testimony of Mr. Saul Levine, an expert and consultant to Commonwealth Edison Company, addresses the "Class 9" contentions in this proceeding, namely Rockford League of Women Voters' Contentions 8 and 62, and DAARE/SAFE contention 2(a). Mr. Levine describes and discusses:

1. NRC's use of the deterministic approach for making safety decisions, and the evolution, uses and limitations of PRA methodology;

2. the development of WASH-1400 and the Lewis Committee's critique of that document;

3. his evaluation of and concurrence with the NRC Staff's discussion of severe accidents in the Final Environmental Statement for the Byron Station;

4. design features incorporated in the Byron design that provide protection against accidents beyond the design basis; and

5. the incremental risk to the residents in the Rockford environs from accidents at Byron Station, taking into consideration the existing risk from other nearby operating nuclear power plants.

Mr. Levine concludes that:

1. Contrary to the assertions in Contention 8, WASH-1400 and its methodology are appropriate for use in estimating public risk from reactor accidents as part of NRC's Final Environmental Statements for reactors, and that the NRC Staff evaluation for Byron Station is reasonable and conservative.

2. Contrary to the assertion in Contention 62, the design of the Byron Station does provide substantial protection against severe or "Class 9" accidents.

3. The incremental risk to residents of the Rockford environs from accidents at Byron Station taking into account the risk from accidents at other nearby operating nuclear power plants is small.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

IN THE MATTER OF
COMMONWEALTH EDISON COMPANY
(Byron Nuclear Power Station Units 1 & 2)

TESTIMONY OF SAUL LEVINE

1. Introduction

My name is Saul Levine, and I am Vice President and Consulting Group Executive, NUS Corporation, Gaithersburg, Maryland.

The NUS Corporation is an internationally known consulting company in the field of energy and has some 1300 employees. My organization is responsible for performing nuclear power plant safety analyses, probabilistic risk assessments and reliability analyses; providing quality assurance services; supplying environmental services; and assisting NUS clients in reactor licensing.

I have been involved with the application of nuclear energy for nearly 30 years. I hold a B.S. degree from the U. S. Naval Academy and two degrees from the Massachusetts Institute of Technology: a B.S. in electronics engineering and an M.S. in nuclear engineering. After serving in the U. S. Submarine Service from 1945 to 1954, I reported, from 1955 to 1958, to

Admiral Rickover as Project Officer for the U.S.S. Enterprise, the world's first nuclear powered aircraft carrier. In this position, I was responsible for directing all technical, financial, production, and administrative aspects of the reactor plant prototypes and the production plants for the U.S.S. Enterprise. From 1958 to 1962, I worked in the U. S. Navy's Special Projects Office, which was responsible for producing the submarine based Polaris Missile System. I managed the design, integration, installation, testing, and performance evaluation of the Polaris Missile Submarine Navigation System.

From 1962 through the end of 1979, I was with the U. S. Atomic Energy Commission (AEC) and its successor, the U.S. Nuclear Regulatory Commisson (NRC). During those years, I was Assistant Director for Reactor Technology, Assistant Director of the Division of Environmental Affairs, Project Staff Director for the Reactor Safety Study (WASH-1400) (1), which represented the first comprehensive evaluation of the likelihood and consequences of nuclear power plant accidents, Assistant Director, Division of Reactor Safety Research, Deputy Director, Office of Nuclear Regulatory Research, and Director, Office of Nuclear Regulatory Research. In 1980 I joined NUS Corporation as Vice President and Consulting Group Executive.

2. Purpose

The purposes of my testimony are to present and support my judgements that

(1) the NRC staff evaluation of the probabilities and consequences of severe accidents at the Byron

Station, as presented in the Byron Final Environmental Statement, represents a reasonable approach and results in a prediction of public risks higher than that which might occur and is therefore conservative.

(2) the Byron Station design, as those of all U.S. commercial nuclear power plants, provides significant protection against severe (so called Class 9) accidents, that is accidents more severe than the traditionally analyzed design basis accidents (DBAs), and

(3) that the cumulative risk to DeKalb-Sycamore and Rockford area residents from accidents at the Byron Station and other plants in northern Illinois is negligible.

My testimony is related to Contentions 8 and 62 introduced by the Rockford League of Women Voters, and Contention 2(A) introduced by DAARE/SAFE.

3. Standard NRC Safety Evaluations

Before proceeding with these discussions, it would be useful to describe briefly the way safety evaluations of nuclear power plants are performed in the Nuclear Regulatory Commission's licensing process. Each plant that is licensed by the NRC has to demonstrate that it meets an extensive set of NRC regulations and other requirements to ensure that operation of the plant will not represent undue risk to the health and safety of the public. These requirements cover the engineering aspects of the plant to achieve high quality in design

and construction so that failures of equipment such as pipes, valves, pumps, electrical and control equipment will not cause accidents that can release large amounts of radioactivity that could harm the public. There are also requirements for the plant to withstand severe external events such as earthquakes, floods and tornadoes that might cause failures in the plant.

In addition to these requirements, several explicitly defined accidents, called design basis accidents or DBAs, are analyzed in the licensing process to demonstrate that people living near the plant will not be subjected to undue risk from radioactive releases. In these accidents, some specified set of initial failures are assumed. The safety systems that are installed in the plant are then analyzed to ensure that they will fulfill their designed functions, and that, as a result, no significant amounts of radioactivity will be released from the plant. All safety systems have redundant components so that failure of single components within the systems will not cause the systems to fail.

As part of the NRC process, it is required that emergency plans be developed so that, in the very unlikely event of a large release of radioactivity, people in the vicinity of the plant can be protected by evacuation.

This NRC process has come to be called "deterministic" because it is not probabilistic in nature. That is, over the years the entire nuclear community, by participating in NRC's process, has defined, by qualitative engineering judgement, as opposed to quantitative probabilistic estimates, those elements that must be considered in safety evaluations and those that need not be considered. This approach to nuclear power

plant safety is followed throughout the world and has produced nuclear power plants with good safety records.

However, the safety evaluations performed in NRC's licensing process do not make quantitative estimates of risk to the public that might occur from plant accidents. Complementary analyses, which are not required by NRC regulations, called probabilistic risk assessments, can be performed to estimate both the probability and the consequences to the public of plant accidents.

4. Probabilistic Risk Assessment

Probabilistic risk assessment can be thought of in simple terms as being a combination of logic structures (event trees, fault trees, etc.) that permits estimates to be made of the likelihood and consequences of accidents that have not been observed because of their low frequency of occurrence. Because equipment failures and human errors are of higher frequency than entire system failures, they are, in fact, observed in the operation of plants. The logic structure of fault trees is such that data obtained on plant equipment failures and human errors can be used to estimate the probability of plant system failures that have not been observed because of their low frequency. The logic structure of event trees is such that the combinations of system failures (accident sequences) that can cause releases of radioactivity to the environment can be defined and their probabilities of occurrence can be estimated from the system failure probabilities supplied by the fault trees.

When the probabilities of various accident sequences have been determined, the physical processes that could occur during these sequences must be analyzed to estimate the amount of radioactivity that could be released to the environment by the various accident sequences. With the probability of releases of various amounts of radioactivity in hand, a further analysis is needed to predict the dispersion of radioactivity in the environment and the health effects induced in people who may be exposed to this radioactivity.

The logic structures described above permit consideration of (1) internal plant failures (equipment failures; human errors in testing, maintenance, and operation; fires; internal floods), (2) events external to the plant (earthquakes, hurricanes, tornadoes, floods) that might cause plant failures, and (3) protective actions like evacuation if a severe accident were to occur.

Before proceeding with a discussion of the Reactor Safety Study it is useful to examine the question of why PRA studies are not and should not be required in safety-related licensing, as opposed to environmental licensing, of individual nuclear power plants such as Byron. There are several reasons for this:

- As I have noted earlier, the existing deterministic regulations have been shown to provide nuclear power plants that present very small risks to the public; thus, a radical departure in the basic philosophy supporting the structure of NRC regulatory requirements is neither necessary nor desirable.

- The predictions of public risk in PRAs have large uncertainties which make the use of such predictions in the safety-related licensing of reactors questionable at this time. However the approach followed by the NRC in its FES is useful because, even in using conservative estimates to account for uncertainties, it is able to show that the risks from potential accidents at the Byron Station are small compared to other risks to which the population in the vicinity of the plant are already exposed.

- It is still too early to codify the performance of full PRAs. PRA is a rapidly evolving methodology and much research is being done that will aid the understanding of, and ultimately reduce the uncertainties involved in predicting, the physical processes associated with molten fuel and fission product behavior. The performance of an increasing number of PRAs is resulting in improvements associated with many other aspects of PRA methods. While the use of full PRAs is now of little utility in the safety-related licensing process, part of the overall PRA methodology, especially that associated with the prediction of system reliability, can sometimes be of help in resolving safety issues in individual licensing cases.

5. Reactor Safety Study (WASH-1400)

As stated earlier, the application of probabilistic risk assessment techniques to nuclear power plants was first done

most comprehensively in the Reactor Safety Study (WASH-1400). This was a landmark study that developed a significant portion of the methodology now used both in the United States and abroad. It has also been demonstrated that WASH-1400 has predicted essentially correctly events that have occurred, such as the accident at the Three Mile Island-2 nuclear power plant.

Of course, since the Reactor Safety Study was completed seven years ago, improvements in the methodology have been made so that the state-of-the-art of probabilistic risk assessment is today significantly advanced over WASH-1400. For example, the data base for equipment performance has been increased significantly by the efforts of the NRC in analyzing Licensee Event Reports and by the efforts of utilities in collecting plant-specific data for PRAs. Much better models are now available for seismic and fire analyses in comparison with the rudimentary models used in WASH-1400. Further, although WASH-1400 made significant steps forward in the modeling of common-cause failures and human errors, further improvements have also been made in these models. Finally, the NRC's research program has led to a better understanding of how unlikely large steam explosions are and of the much slower reaction that would occur between molten fuel and concrete; also industry's efforts in better describing the physical phenomena associated with molten fuel are important.

The charter of the Reactor Safety Study (WASH-1400) was to make quantitative predictions of the risks to the public from potential accidents from 100 operating nuclear power plants. This was done by analyzing in great detail two specific reactors (a pressurized water reactor and a boiling water reactor)

and extrapolating this information to an assumed population of 100 reactors at a "composite" site that included the significant characteristics of the sites at which these reactors were located. The site characteristics included population and meteorological features of 68 different sites. The major result of the Reactor Safety Study was that the risk from a population of 100 reactors in the United States was estimated to be very small when compared to other existing risks in our society.

The Reactor Safety Study generated a considerable amount of controversy when it was published. In response to a request from the Congress, the Nuclear Regulatory Commission established a Risk Assessment Review Group, chaired by Professor Harold Lewis, University of California, Santa Barbara. This group has subsequently become known as the Lewis Committee. The charter for this group was, in part, to clarify the achievements and limitations of WASH-1400, to study the present state of such risk assessment methodology, and to recommend to the Commission how such methodology could be used in the regulatory and licensing process.

6. Contention 8

I have examined Contention 8 and note that it is incorrect in many respects. It states that "...the Lewis Committee has now called into serious question the entire methodology, as well as the findings and conclusions, of the Rasmussen Report..." (WASH-1400). It is true of course that the Lewis Report did criticize certain aspects of WASH-1400, especially the Executive Summary and the uncertainty associated with its probability predictions. However, I should note a few points from the

summary and findings of the Lewis Committee Report (NUREG/CR-0400)[2] that will demonstrate the basic inaccuracy of this statement. I share these viewpoints.

- Event tree/fault tree methodology is demonstrably sound.

- These methods provide a substantial advance over previous attempts to estimate the public risks from nuclear power plants. Event tree/fault tree methodology and other aspects of the modeling have set a framework that can be used broadly to address choices involving both technical consequences and impacts on humans.

- The event tree/fault tree approach with an adequate data base is the best available tool with which to quantitatively predict the probabilities of reactor accidents.

The Lewis Report also contained a number of important recommendations, the complete text of which is included as an addendum to my testimony. The basic thrust of these recommendations is that the WASH-1400 methodology should be applied to re-examine and improve the fabric of the entire regulatory process. Clearly the authors of the Lewis Report share my views that the proper application of the WASH-1400 methodology is of great value.

Similarly, the statement by the NRC Commissioners in light of the Lewis Committee Report is not as negative as asserted by Contention 8. After citing the Lewis Committee discussion of

the limitations of WASH-1400, the Commission statement[3] concludes as follows:

> "Taking due account of the reservations expressed in the Review Group Report and in its presentation to the Commission, the Commission supports the extended use of probabilistic risk assessment in regulatory decisionmaking."

It is important to draw a distinction between regulatory decisionmaking, which encompasses virtually all of the activities of NRC, and licensing decisionmaking, which is the much narrower NRC function of making decisions on whether or not to issue construction permits or operating licenses for individual plants. It is my view that PRA has several uses in generic regulatory decisionmaking, where precision is not required, but very limited applications in making decisions on specific licenses, where the focus is on compliance with regulations. Examples of useful generic regulatory applications involve the examination of existing and proposed regulatory requirements, establishing research priorities, evaluating priorities and proposed resolutions for generic safety issues, and evaluating the significance of selected individual safety issues. Licensing applications of PRA on individual plants should be limited to specific safety issues in controversy where the insights attainable from PRA techniques are helpful in understanding the significance of tne issues.

More recently, the use of PRA in generic regulatory decisionmaking has been strongly endorsed by the reports of the President's Commission on the accident at Three Mile Island (Kemeny Report)[4] and the NRC Special Inquiry Group (Rogovin

Report)[5]. The NRC staff has used the PRA techniques pioneered by WASH-1400 in many different contexts, including final environmental statements[6].

The following are some examples of recent Commission statements on using PRA techniques:

a. In an October 8, 1981 letter[7] to the NRC Executive Director for Operations establishing a Generic Requirements Review Committee (GRRC), NRC Chairman Palladino states, "Tools used by the GRRC for scrutiny would be expected to include cost-benefit analysis and probabilistic risk assessment where data for its proper use are adequate." This means that PRA techniques will be used, where sufficient data exists, to contribute to NRC decisions concerning whether proposed new regulatory reguirements are necessary.

b. In the discussion paper accompanying the proposed policy statement on safety goals (NUREG-0880)[8], issued by the Commission, is the following statement:

"In summary, we believe that progress in the development of probabilistic risk assessment and the accumulation of the relevant data base are sufficient to make it feasible to use quantitative reactor safety guidelines for limited purposes."

c. The summary of the NRC statement of interim policy on nuclear power plant accident considerations under NEPA[10] states as follows:

"It is the Commission's position that its Environmental Impact Statements shall include considerations of the site-specific environmental impacts attributable to accident sequences that lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and to melting of the reactor core. In this regard, attention shall be given both to the probability of occurrence of such releases and to the envinronmental consequences of such releases."

In my earlier position as Director of the Office of Nuclear Regulatory Research at NRC I directed several useful applications of PRA, and I would like to discuss three of these applications here.

One interesting application was the divergent opinions expressed by four NRC staff members several years ago. They raised fifteen issues supposedly related to safety and not being handled adequately by the Regulatory staff. I received a letter from Senator Glenn asking me for my independent views on these issues.

The issues fitted into one of several categories. Four of tne issues related to procedural matters which had no safety impact on reactors. The remaining fit into one of two categories. One category was accident sequences that had very small releases of radioactivity to the environment which would result in negligible public health impacts and, therefore, were not of significant concern to safety. The remaining sequences fit into a category of accidents that could have significant potential releases of radioactivity; but the items of concern in these accident sequences were so far down the chain

of probabilities that they could not affect the outcome of the accident in any significant way. Thus, through the application of PRA techniques, these issues were demonstrated to be insignificant in terms of risk to the public.

An NRC staff effort, which I directed, used PRA techniques in a reliability context in a comprehensive generic study[9] of the reliability of auxiliary feedwater systems in reactors designed by different manufacturers. Although this study examined a specific issue, namely the reliability of auxiliary feedwater systems, it was also generic in that a large number (25) of pressurized water reactor auxiliary feedwater systems were examined. The results showed a wide variation in reliability from plant to plant. As a direct result of the study, modifications to improve reliability were identified in several plants, and these modifications were implemented.

Another application that I was involved in concerned generic safety issues. There had existed for some time 133 unresolved or generic safety issues that had arisen in the licensing process. These were examined by the use of probabilistic techniques and it was determined that only about 20 of these were of any direct safety significance and the others were of very little concern. Thus, the 133 items were reduced to about 20 in a one month analysis.

I therefore conclude, contrary to the assertions in Contention 8, that both the Lewis Report itself and the subsequent NRC statement on WASH-1400 in light of the Lewis Report were supportive of the concept of making use of the PRA methodology pioneered by WASH-1400 in NRC's regulatory process. In addition, recent independent evaluations of the NRC, by the Kemeny

and Rogovin Committees, have recognized the advantages of PRA methods and specifically recommended their use in regulatory decisionmaking. I have given many papers and speeches over the last few years that reached the same conclusion. (Examples are References 15, 16, and 17.)

Continuing with the discussion of Contention 8, it states, referring to WASH-1400, that "...the staff still regulates upon the validity of the basic conclusions therein." This statement is fundamentally in error. The NRC staff does not, and has not, regulated nuclear power plant safety based on the conclusions of WASH-1400 or of any probabilistic risk assessment; it uses the deterministic approach discussed earier in Section 3 of this testimony. PRA evaluations have not been and are not a part of the licensing process for nuclear power plants such as the Byron Station.

Contention 8 further concludes that "the withdrawal of NRC's endorsement of the Reactor Safety Study and its findings leaves no technical basis for concluding that the actual risk is low enough to justify operation of Byron." This excerpt from the contention contains two errors of fact. First, the NRC did not withdraw its endorsement of the study and its findings, but rather withdrew its endorsement of the Executive Summary of the study, which has nothing to do with the technical quality of the study itself. Secondly, as just stated, the NRC staff does not use, and has not in the past used, the Reactor Safety Study as the technical basis for safety decisions regarding nuclear power plants.

Contention 8 characterizes the Byron site as a "high population density" site. An NRC document[11] is available that

compiles and presents demographic characteristics for all existing or proposed nuclear power reactor sites. This document reveals that the Byron population density is generally much less than the average of the 111 sites shown, for distances out to 50 miles. It is therefore incorrect to characterize the Byron site as a "high population density" site.

With regard to the substance of the Byron FES, I have examined pages 5-44 through 5-67 thereof, dealing with the risks of severe accidents.

With regard to the core fission product inventory release fractions tabulated in Table 5.11, I share the judgement, growing in the nuclear technical community, that these values are too large. The approach used to calculate the numerical values of probabilities, public exposures and health effects presented in Table 5.12, "Summary of Environmental Impacts and Probabilities," appears reasonable. Evolving work on source terms and other accident phenomena will almost surely show, within a few years, that the tabulated impacts are conservative. The complementary cumulative distribution functions (CCDFs) for early and latent fatalities, shown in Figures 5.8 and 5.9 respectively, appear to be conservative approximations based on current knowledge.

In reaching a judgement on the adequacy of the Class 9 accident calculations reported in the Byron FES, I considered the following:

- the adequacy of the methods and results reported in the FES as compared to those from other PRA evaluations;

- the balance between uncertainties and conservatisms in the reported analysis, and

- the degree of precision required in the way the results are applied to decisionmaking.

Each of these considerations is discussed below.

The approach used in the Byron FES is consistent with present practices by PRA practitioners. The body of knowledge accumulated since (and including) the Reactor Safety Study (WASH-1400) supports the general levels of risk reported in the FES, and suggests that the FES values are conservative.

Probable conservatisms in source terms (the fractions of core fission product inventories released) have been referred to above. Other probable sources of conservatism that seem to be emerging from ongoing research are a reduced likelihood of steam explosions, which would make this failure mode of the pressure vessel or containment less likely than previously estimated; longer times for containment failure, which would allow more time for fission product plateout and deposition, resulting in smaller releases; and a reduced rate of containment basemat penetration by a molten core which would result in delays and reductions in fission product release to groundwater.

These probable conservatisms must be balanced against uncertainties. For example, there is substantial uncertainty in the accident sequence probabilities cited in Table 5.11 on page 5-45 of the FES. These uncertainties relate to the quantification of human error probabilities, inadequacies in the data base for component failure rates, and the frequencies of

external events (tornadoes, floods, earthquakes) or successful sabotage of the plant. Additional uncertainty is introduced in the models and techniques used for site-dependent consequence calculations, including those for weather conditions, public protective actions and health effects. In sum, the FES strikes a balance between conservatisms and uncertainties on the side of conservatism.

The third consideration listed above was the degree of precision required in the way the analytical results were applied in decisionmaking. The FES PRA results are used, as reported in Table 6.1 of the FES (p 6-3), to assist in formulating a judgement as to whether the radiological impact on human health from reactor accidents should be classified as small, moderate or large. It is my view that great precision is not required for this application, especially since the risks predicted from nuclear power plant accidents are so much smaller than the risks to which society is already exposed.

I conclude that the approach described in the FES is reasonable, and further that the estimated risks are conservative in light of current and evolving knowledge concerning fission product source terms and other severe accident phenomena. I concur with the NRC staff judgement (FES P 5-67) that the risks of acute fatality from potential accidents at the site are small in comparison with acute fatality risks from other human activities in a comparatively sized population.

7. Contention 62, Accident Mitigation

Contrary to the assertion of Contention 62, the design of Byron Station does provide substantial protection against severe (so called "Class 9") accidents. The protection provided

by Byron Station design features falls into two categories, prevention of severe accidents and mitigation of their consequences should they occur. The WASH-1400 Report and later PRA studies have all shown that plant structures, systems and components incorporated in the design to protect against design basis accidents have substantial capabilities for providing protection against more severe accidents as well. A few of the relevant Byron design features, and their protective functions provided, are described below.

a. Reactor Protection System and Backup Shutdown System

These systems assist in preventing severe accidents by shutting down the neutron chain reaction and thereby reducing the core power to very low levels in response to specified signals. This makes the probability of accidents characterized by failure to shut down the reactor very small.

b. Emergency Core Cooling System (ECCS)

The ECCS consists of several sources of water and delivery systems designed to prevent severe accidents by preventing reactor core melting in the unlikely event that normal fuel cooling water is lost. The Byron ECCS design incorporates both hot leg and cold leg injection, and includes a low-pressure passive accumulator system, consisting of four pressure vessels partially filled with borated water; two high head injection system pumps, two intermediate head injection system pumps, and two low head residual heat removal pump subsystems. The

appropriate injection systems take suction from the refueling water storage tank (350,000 gallons) during the short-term injection phase, and are aligned to other water sources for long-term recirculation. The ECCS will perform its design function with one accumulator failed and with only one of the redundant trains of safety injection at the applicable pressure level. The Byron ECCS design features make the probability of losing core cooling very small.

c. Containment building

Provides protection against both design basis accidents and more severe accidents by either preventing releases of significant amounts of radioactive materials to the environment or, for very unlikely severe accidents, substantially reducing the size of releases. The Byron containment has a free volume of about 3 million cubic feet and a design pressure of 50 psig. This combination of volume and pressure capacity results in a very low probability of containment overpressure failure for severe accidents; furthermore, even in those accidents where the containment might ultimately rupture, this would occur some hours after the accident, thus allowing significant time for removal and plateout of radioactive materials from the containment atmosphere so that the amount released to the environment would be significantly reduced. The end result is a low probability of containment failure with the Byron design.

d. Containment Spray and Fan Coolers

These safety-grade systems perform two important functions that mitigate the consequences of severe accidents and design basis accidents. These functions are (1) decreasing the containment pressure by cooling the containment atmosphere to reduce leakage from the containment to the environment and prevent overpressure rupture of the containment, and (2) removing radioactive materials from the containment atmosphere so that only small amounts would be released to the environment. Both of these functions reduce the probability of large releases of radioactivity to the environment.

e. Auxiliary Feedwater System

The auxiliary feedwater system (AFWS) is designed to provide an alternate means of providing water to the secondary side of the steam generators in the event of a loss of main feedwater supply. This backup system provides redundancy in the important accident prevention function of removing heat from the reactor coolant system and, in turn, from the reactor fuel. The system consists of two redundant, safety-related essential trains and one nonessential (startup) train, all of which supply water to all four steam generators. Redundant power supplies are also provided, and the pumps start automatically in transient or accident situations. This system has been shown to be important in many PRA studies, and the Byron design has benefited from the knowledge gained in these earlier studies.

f. Items (a) through (e) above do not constitute an all-inclusive list. Many other components and systems could be added, including post-TMI modifications such as the safety parameter display system, reactor vessel head vent system, core saturation monitors, reactor vessel water level indication, improved accident monitoring instrumentation and dedicated emergency response facilities. Many of the post-TMI modifications are directed toward improving the cognitive reaction of the operators, i.e. assisting the operators in correctly diagnosing the condition of the plant. The precise value of these cognitive aids is difficult to quantify in terms of risk reduction, but they are being incorporated and will assist in providing protection against both design basis accidents and more severe accidents.

Based on the foregoing discussion I conclude that it is incorrect to assert, as in Contention 62, that the Byron Station design does not provide protection against severe accidents.

8. Incremental Risk from Byron Station

DAARE/SAFE Contention 2(A) contends that, with the addition of two more nuclear power units in operation at Byron, the potential for cumulative dose effects from discrete accident events at plants in Northern Illinois poses an unreasonable level of risk to the health and safety of DeKalb-Sycamore and Rockford area residents.

Risk is composed of two component parts, the probability of an occurrence and its consequences. Consequences are probably conservatively estimated by present techniques, as discussed

earlier. Most of the plant-specific PRA evaluations that I have seen to date indicate that the probabilities of core melt accidents at nuclear plants are small, generally on the order of one in ten thousand per reactor-year. Further, few core melts are estimated to result in off-site health effects.

Important factors affecting the public risks from nuclear power plant accidents are the distances from the plant to population centers. In terms of distance, Rockford is located about fifteen miles from the Byron Station, and sixty miles or more from the Zion Station, the next nearest plant to Rockford. DeKalb and Sycamore are about thirty miles from the Byron Station, and forty miles or more from the Dresden and LaSalle plants, which are about equally distant from these communities.

In considering the possibility of increased risks to the residents of the Rockford and DeKalb-Sycamore areas, one should examine the two principal health effects that might occur as a result of nulcear plant accidents. These are early fatalities and latent cancer fatalities.

PRA evaluations have shown that the accident risk of early fatality to people living at distances of fifteen miles or more from a nuclear plant is exceedingly small. Thus there would be no coupling of early fatality risks from multiple plants to the localities being discussed here.

With regard to latent cancer fatality risks, typical estimates from PRA studies show that the probability that an individual will die from cancer as a result of radiation exposure from

very severe nuclear power plant accidents is negligibly small compared to the probability of dying from cancer contracted from other sources. The average probability of cancer fatality per year per individual in the United States is about one in five hundred. NUS estimates indicate that the chance of a person dying from reactor accident caused cancer in the region ten to twenty miles from the reactor is about one chance in a billion per year.

An examination of these probabilities shows that the naturally occurring cancer risk is on the order of two million times larger than the cancer risk from nuclear plant accidents at the distances of interest. It is therefore inconsequential to an individual's cancer fatality risk whether he resides at the distances of interest from one or several nuclear power plants.

In a September 10, 1982 Memorandum and Order[12], this Board referred to an NRC report, NUREG/CR-2497[13], commonly known as the precursor report. The precursor report presents an estimate of the frequency of severe core damage based on accident precursor events identified from Licensee Event Reports (LERs). One of the events, the accident at Three Mile Island, did indeed lead to core damage, and since during the time period covered by the report there were 432 years of domestic reactor operation, the frequency of core damage from this type of event was estimated as 1/432 per reactor-year, or about 2×10^{-3}.

The impact of the precursor events identified in the LERs on the predicted frequency of occurence of severely damaged cores

was analyzed by means of event trees to identify the possible accident sequences that might occur given that event. The conditional probability of "severe core damage" was then calculated by associating the LER frequency with the probabilities of failure of the remaining mitigating functions that could prevent core melt. These probabilities of failure were obtained either from LERs, from PRAs, or from other published documents. The important point, however, is that the precursor report used generic numbers that were fed into generic event trees. Thus no account is taken of the particular plants to which the very infrequent precursor events apply or of the specific event trees and the specific system failure probabilities that would be applicable to that particular plant. The generic approach used in the precursor report will almost certainly yield predicted failure probabilities that are too high.

The recently released Institute of Nuclear Power Operations (INPO) analysis[14] of the precursor report is properly directed to the specific plants where the precursor events occurred. This INPO report found that when the actual detailed plant configurations are taken into account, generally lower core damage probabilities are obtained, often by factors of 1/10 to 1/1000. The core damage probability estimates in the precursor report, not including the TMI-2 accident, average about 30 times higher than the INPO estimates. These differences are due principally to the simplified models and simplified assumptions used in the precursor report.

While the idea of using precursor events as data to help improve the predicted probabilities of accident sequences is

conceptually interesting, it appears to have been misused in the precursor report. If this type of analysis is to be done, it must be done in such a way that the precursor event is analyzed using event trees and system failure data that are applicable to the plant at which the precursor event occurred. Anything less than this leads to ill-defined and murky results. It is my judgement that the INPO estimates of severe core damage probabilities are technically superior to those of the precursor report, and generally in agreement with earlier studies.

Conclusions

As a result of the examination I have made of Contention 8, 62 and 2A, I conclude that they raise issues which are either incorrect or have no significant impact on the validity of Commonwealth Edison's or the NRC's approach to the safety of the Byron Station.

In regard to Contention 8, the principal points raised are that the NRC regulates nuclear power plant safety on the validity of the basic conclusions in WASH-1400 and that the NRC has withdrawn its endorsement of WASH-1400, thus leaving no technical basis for concluding that the "risk is low enough to justify operation of Byron." As stated in Section 3 of this testimony, the NRC has not and does not license the safety of reactors based on the conclusions of WASH-1400 or of any other PRA but on the basis of its regulations and the deterministic licensing process. Nor, as discussed in Section 6 of this testimony, has the NRC withdrawn its endorsement of WASH-1400, but in fact supports the use of PRA methodology for appropriate purposes and has instructed the staff to use these methods in estimating public risk from reactor accidents as part of NRC's final environmental statements for reactors.

In regard to Contention 62, as noted in Section 7 of this testimony, the Byron Station design does incorporate design features that provide substantial protection against severe (so called Class 9) accidents. These design features reduce the probabilities and significantly mitigate the consequences of severe accidents.

In regard to Contention 2A, the incremental risk from accidents at Byron Station to the residents of the Rockford and DeKalb-Sycamore areas is estimated to be exceedingly small. The "precursor report," which estimates higher probabilities of severe core damage accidents than had previously been estimated, is flawed and its probability estimates are too high.

This concludes my prepared testimony.

References

1. WASH-1400 (NUREG-75/014), "Reactor Safety Study, An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," U. S. Nuclear Regulatory Commission, October 1975

2. NUREG/CR-0400, "Risk Assessment Review Group Report to the U. S. Nuclear Regulatory Commission," H. W. Lewis, Chairman, September 1978

3. "NRC Statement on Risk Assessment and the Reactor Safety Study Report (WASH-1400) in Light of the Risk Assessment Review Group Report," U. S. Nuclear Regulatory Commission, January 19, 1979

4. Report of the President's Commission on the Accident at Three Mile Island, J. G. Kemeny Chairman, October 31, 1979

5. Three Mile Island, A Report to the Commissioners and to the Public, Nuclear Regulatory Commission, Special Inquiry Group, M. Rogovin, Director, January 1980

6. "Various Applications of Probabilistic Risk Assessment Techniques Related to Nuclear Power Plants," presented by Saul levine, NUS Corporation, at the Annual meeting of the National Safety Council, Chicago, Illinois, October 1980

7. Memorandum for William Dircks, Executive Director for Operations, from N. J. Palladino, Chairman USNRC, "Reactor Requirements and Regional Office Reorganization," October 8, 1981. (Note that the name of the Generic Requirements Review Committee was later changed to the Committee to Review Generic Requirements.)

8. NUREG-0880, for comment, "Safety Goals for Nuclear Power Plants: A Discussion Paper," U. S. Nuclear Regulatory Commission, February 1982

9. NUREG-0560, "Staff Report on the Generic Assessment of Feedwater Transients in Pressurized Water Reactors Designed by the Babcock & Wilcox Company," US NRC, May 1979

NUREG-0611, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Westinghouse-Designed Operating Plants," U S NRC, January 1980

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NUREG-0635, "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in Combustion Engineering Designed Operating Plants,." January 1980

10. 45 FR 40101, "Statement of Interim Policy, Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969," U. S. Nuclear Regulatory Commission, June 13, 1980

11. NUREG-0348, "Demographic Statistics Pertaining to Nuclear Power Reactor Sites," U. S. NRC, October 1979

12. USNRC, Atomic Safety and Licensing Board, In the Matter of Commonwealth Edison Company (Byron Station, Units 1 and 2), "Memorandum and Order Ruling on Motions for Summary Disposition of DAARE/SAFE Contentions," September 10, 1982, P. 12

13. NURG/CR-2497, "Precursors to Potential Severe Core Damage Accidents: 1969-1979, A Status Report," prepared for U S NRC by Oak Ridge National Laboratory, June 1982

14. INPO 82-025, "Review of NRC Report: Precursors to Potential Severe Core Damage Accidents: 1969-1979, A Status Report, NUREG/CR-2497," Institute of Nuclear Power Operations , September 1982

15. "Various Applications of Probabilistic Risk Assessment Techniques Related to Nuclear Power Plants", presented by Saul Levine, NUS Corporation, at the Annual Meeting of the National Safety Council, Chicago, Illinois, October 1980.

16. "Light Water Reactor Safety", presented by Saul Levine, NUS Corporation, to the American Nuclear Society Annual Meeting, Miami, Florida, June 1981.

17 "PRA for Safety Goal Compliance", presented by Saul Levine, NUS Corporation, to the American Nuclear Society Winter Meeting, Washington, D.C., November 15, 1982.

ADDENDUM

Recommendations from NUREG/CR-0400, "Risk Assessment Review Group Report to the U. S. Nuclear Regulatory Commission," September 1978

RECOMMENDATIONS

- Re-evaluate NRC's inspection and quality assurance system and licensing criteria to determine the extent to which they incorporate those things that have been learned from WASH-1400 and other relevant literature.

- Use WASH-1400 probabilistic methodology more effectively to guide the reactor safety research program so as to reduce the uncertainties in analysis, and to gain greater understanding of those points of risk uncovered.

- Where there is an inadequate data base, the methodology of WASH-1400 can still be used to uncover the topology of accident sequences. In such cases the limits of knowledge should be stated, without pressure to quantify (other than bounding) that which is unquantifiable.

- Communicate to the relevant branches of Government (e.g, Department of Energy) the desirability of performing risk assessments on electric generating technologies alternative to light-water reactors.

- In general, avoid use of the probabilistic risk analysis methodology for the determination of absolute risk probabilities for subsystems unless an adequate data base exists and it is possible to quantify the uncertainties. However, the methodology can also be used for cases in which the data base will only support a bounding analysis, and for other cases in the absence of any better information if the results are properly qualified.

- Fault-tree/event-tree analyses should be among the principal means used to deal with generic safety issues, to formulate new regulatory requirements, to assess and revalidate existing regulatory requirements, and to evaluate new designs.

- NRC should encourage closer coordination among the research and probabilistic analysis staff and the licensing and regulatory staff, in order to promote the effective use of these techniques.

- The consequence model used in WASH-1400 should be substantially improved, and its sensitivities explored, before it is used in the regulatory process.

MR. GALLO: The witness is available for cross examination.

MR. THOMAS: At this time, your Honor, I would ask leave to file on behalf of the League a cross examination plan with respect to Mr. Levine.

May I proceed, your Honor?

JUDGE SMITH: Yes.

CROSS-EXAMINATION ON BEHALF OF INTERVENOR ROCKFORD LEAGUE OF WOMEN VOTERS

BY MR. THOMAS

Q Mr. Levine, when were you contacted by Commonwealth Edison with regard to serving as a consultant in this proceeding?

A I can't recall the exact date, but two or three months ago.

Q Prior to that time did you have any familiarity with the Byron Nuclear Power Station?

A No; only in the sense that it was a large light water reactor.

Q Do you remember who made the contact with you?

A I believe it was Mr. Gallo.

Q Okay. What were you asked to do?

A I was told that there were three contentions that they would like me to testify about and would I be willing to do that.

Q Did you discuss at that time the nature of your testimony?

A Not in any specificity.

I read the contentions and I gave forth some ideas about these contentions.

Q All right. At that time did you discuss financial arrangements for your serving as a consultant?

A No.

MR. GALLO: Objection -- I will withdraw the objection. The witness has answered the question.

MR. THOMAS: Well, I am going to get to that issue, if you want to --

MR. GALLO: I would object to any further questions about the financial arrangements between Mr. Levine and Commonwealth Edison. They are irrelevant to this proceeding.

JUDGE SMITH: Well, I would say that the specifics of the amount would be irrelevant, but the fact that he is a paid witness, paid to testify on behalf of the utility --

MR. GALLO: I will stipulate to that.

JUDGE SMITH: -- which is fairly inferable from his presence, is relevant.

MR. GALLO: I will stipulate, your Honor, that he is a paid witness.

MR. THOMAS: Judge, I think that the specifics of the financial arrangements are relevant.

JUDGE SMITH: You mean the exact amount of money?

MR. THOMAS: Or an hourly rate or whatever the financial arrangements are.

Certainly, certainly, that is a common subject of bias in any type of proceeding; and I don't think that the bias here is any less than it would be in any other type of proceeding.

JUDGE SMITH: I think that you can fairly inquire into non-monetary terms of his contract that might indicate bias and you can establish that the amount that he is being paid, if such be the case, is consistent with a man of his professional attainments and whatever; but the record does not necessarily have to know the exact dollars and cents of his compensation.

I might say, frankly, Mr. Thomas, that I have not had this exact situation arise in a licensing-type proceeding, so I am sort of going by the seat of my pants on it, I will admit; but I still do not see why this record requires that we know the exact dollars and cents of his compensation.

I think you can establish that it's unsubstantial or insubstantial or traditional or consistent.

MR. THOMAS: I have no way of doing that without knowing the amount.

I would just say, your Honor, that the larger the compensation, the more inference of bias that would arise from the nature of the consulting contract. That would certainly -- that would be my argument.

JUDGE SMITH: The inference is that if the compensation rises to such a magnitude, that the person would be induced to testify contrary to truth?

MR. THOMAS: Well, would be induced to testify -- let's say, to resolve doubts in favor of the party who is paying him a very large fee.

I certainly don't think that is beyond the ken of human experience.

JUDGE SMITH: Do you intend to establish, through any witness other than Mr. Levine, what is a very large fee?

What is the amount that would require -- that would overtip the balance over to bias?

I mean, this Board is not expert on it, as you might well guess, being federal employees.

MR. THOMAS: Well, having no idea what the amount is, I haven't given any consideration to a witness on that subject at all.

MR. GALLO: Judge Smith, may I be heard?

JUDGE SMITH: Certainly.

MR. GALLO: It seems to me that consultants in

all forums of litigation are paid for their services. Some are not, but most are. It is routine for these consultants to be paid.

The mere establishment of the amount of the payment doesn't establish bias whatsoever. Indeed, counsel has to go further and point out, as I think you have, that the figure is out of bounds or extremely high in comparison to what other consultants are paid. He is not prepared to do that.

I think the inquiry is largely irrelevant; and if there is bias here and he wants to establish it, there are other means to attempt to do that other than to simply inquire into the compensation paid to this witness.

I think fundamentally there is a problem with the presumption, as counsel is asserting in his argument, that simply because a witness is paid, he is biased. I think that's not true at all.

MR. THOMAS: Well, we could argue about that all day.

JUDGE SMITH: Why don't you establish whatever you choose to establish, in nonspecific terms, the basis for his payment, is it hourly, is it lump sum or that type of thing; but just do not require the specification of the dollars and cents.

You ask him if he knows if it's consistent with what

the general consulting business in his field is paid, if you wish.

You don't have to go into the dollars and cents.

MR. THOMAS: But --

JUDGE SMITH: Well, the Board agrees that my previous discussion will obtain.

MR. THOMAS: Okay. Just so the record is clear, you are sustaining the objection to that question, to the question pending?

JUDGE SMITH: It's a soft sustaining. We are giving you some latitude here.

MR. THOMAS: Well, all right. But as to the specific dollar figure, you are sustaining the objection?

JUDGE SMITH: Yes, yes.

BY MR. THOMAS:

Q Were the terms of the compensation set during your initial conversation with Mr. Gallo?

A I don't believe there was any discussion of that in the initial discussions.

Q I take it at some point since that time they have been set?

A I was not involved in that.

We have a standard rate sheet for people employed at NUS, and that rate sheet was used in establishing the financial arrangement.

Q If you weren't involved, how do you know that that is the case?
A Because my assistant, Fred Stetson, told me he made the arrangements with Mr. Gallo.
Q Is that standard sheet based on an hourly rate?
A Yes.
Q And is there a different hourly rate for your testimony here as opposed to time spent outside the hearing itself?
A No, there is not.
Q How many hours have you expended to date in preparation for your testimony here?
A I have not kept track of that.

I would suspect it's in the neighborhood of 10 to 20 days, but I am just guessing.

Q Have you billed Commonwealth Edison or the Applicant at all yet or whatever person you are going to bill for your testimony?
A I assume my company has, yes.
Q But you don't know for sure?
A I don't know.
Q Is that the practice of your company, to bill as you go along?
A Yes.
Q Do you know whether any payment has been received yet on those bills?

A I do not.
Q Have you ever consulted before for Commonwealth Edison?
A Yes, I believe so.
Q Approximately how many times?
A Well, I think once.
Q In what connection did that take place?
A In the -- there was a peer review group or a peer review Board hired by the combination of Commonwealth Edison, Consolidated Edison and PASNY, to aid in the review of the Zion and Indian Point PRA's.
Q Can you tell me approximately when that was, roughly?
A One to two years ago.
Q As best you can remember, that's the only prior time that you consulted with Edison?
A That is the only time.
Q Since your initial contact regarding this matter, what have you done with regard to Byron specifically to prepare for your testimony?
A I have read the contentions. I have read applicable portions of the final environmental statement. I have read the applicable portions of the NRC Safety Evaluation Report. I have read some other documents. I refreshed my memory about the Lewis Report; and mostly I spent most of my time writing my testimony and having meetings with regard to the testimony.

Q Meetings with whom?
A W'th counsel for Commonwealth Edison and technical people with Commonwealth Edison.
Q Can you indicate what technical people you are referring to?
A George Klopp.
Q What is his area?
A He -- I don't know his exact title; but he is responsible for PRA's within Commonwealth Edison.
Q For the record, is that K-l-o-p-p?
A Yes.
Q Have you met with anybody else from Edison?
A There may have been other people at some of the meetings, but I don't recall who they were.
Q Okay. Have you ever visited Byron?
A No, I have not.
Q Have you -- you say you have read the applicable portion of the SER and the EIS.

I take it, then, you haven't read the entire -- those entire documents?

A That's correct.
Q Have you ever read the FSAR?
A No, I have not.
Q Have you ever read the FES?

MR. GALLO: Clarification on FES.

You mean final environmental statement?

MR. THOMAS: Yes.

MR. GALLO: I object to the statement. He has answered that he has.

A Yes.

JUDGE COLE: I believe he said he read the applicable parts of the FES.

A (Continuing.) Yes.

MR. THOMAS: Right.

JUDGE COLE: Do you mean the environmental report, sir, Mr. Thomas?

MR. THOMAS: I mean the final environmental statement.

JUDGE COLE: The NRC Staff's statement?

MR. THOMAS: Right.

JUDGE SMITH: Now, he hasn't answered the question.

It is not the same question.

MR. THOMAS: I didn't think it was, either.

JUDGE SMITH: So your objection is overruled.

A (Continuing.) I have read applicable portions of the FES.

BY MR. THOMAS:

Q I take it that you or -- strike that.

Have you done a PRA regarding Byron?

A No, I have not.

Q Have you made any structural analysis of the Byron containment?
A No, I have not.
Q Have you analyzed the Byron control room design?
A No, I have not.
Q Have you read or analyzed -- strike that.
Have you read the Byron operating procedures?
A No.
Q Have you done any studies regarding external events at Byron?
A No.
Q Have you read any studies regarding external events at Byron?
A No.
Q Have you done any studies regarding emergency planning concerning Byron?
A No.
Q Have you read any studies on that subject?
A No.
Q Now, in your testimony you indicate that, well, from 1962 through the end of 1979, you were with the AEC and the NRC; is that correct?
A Well, in those dates I would have been with the AEC, because the NRC did not exist until 1975.
Q You say through the end of 1979?

A Oh, that's right; '79, yes, that's correct.
Q Okay. And during those years you held a variety of positions, one of which was Project Staff Director for the Reactor Safety Study WASH-1400?
A Yes.
Q Now, since that is involved in your testimony, exactly what were your duties as Project Staff Director for the Reactor Safety Study?
A The Reactor Safety Study was directed by Professor Rasmussen from MIT, who worked half-time at the AEC, NRC, during the course of when the study was done.

I was the full-time AEC employee to keep the work going and make technical contributions, to direct the staff, to have discussions with Rasmussen about how the study should be performed and so forth.

Q Okay. Then would it be fair to describe you as the -- at least the in-house project director of that report?
A That's a fair statement, yes --
Q Okay.
A -- although, I would say that there is a very close intellectual cooperation between myself and Rasmussen.
Q Yes. I was not trying to exclude him. I was just trying to understand your role.
A Okay.
Q When were you appointed Project Staff Director,

approximately, to the best of your recollection?
A About September of 1972.
Q And how long did you serve as Project Staff Director for the Reactor Safety Study?
A Until the final report was published in October of 1975.
Q Can you give me a rough estimate of the amount of your time that you spent on the Reactor Safety Study during that approximately three-year period?
A Except for a brief period of several months -- I don't recall exactly how long -- when I was helping Dr. Kautz establish the Reactor Safety Research Division in the AEC, I would say I spent an average of 18 hours a day during that whole time period.
Q Okay. So I take it that would be 100 percent of your time other than --
A Yes.
Q All right. Now, I take it, from what the Board indicated, that you still serve the NRC as a consultant in some capacities, if that would be the correct --
A I have a small consulting contract with the Director of the Office of Policy Evaluation of the NRC.
Q Was it pursuant to that contract that, for example, you talk with or that you lecture people, hearing officers, with regard to probability studies, for example?
A No. Those lectures were given when I was in the NRC.

Q Oh, all right.

Can you indicate, just roughly, what the nature of your consulting contract is with the NRC?

A Principally, I have given advice to the head of OPE on safety goals, matters affecting safety goals.

Q And approximately how much of your time does that contract involve?

JUDGE SMITH: Now, you know, there is an unusual problem present here.

There is no authorized representative of the Office of Policy Evaluation present.

It's not the Staff's responsibility to represent them in this hearing. To the contrary, they are specifically divided.

OPE participates in a decision-writing process for the Commissioners themselves.

They are entitled to confidentiality in that function.

I don't know how far you are going to go along that line --

MR. THOMAS: Well, I --

JUDGE SMITH: -- but this is part of the decision-making process --

MR. THOMAS: Yes.

JUDGE SMITH: -- part of it.

Part of it is policy process, which is not protected necessarily; but be sensitive to that.

The Commissioners are entitled to absolute confidentiality in the inputs in their adjudicative decisions, including their consultants.

So I am not going to permit this line of questioning, other than -- well --

MR. THOMAS: Well, I --

JUDGE SMITH: I am not going to permit it; that's the ruling.

MR. THOMAS: I didn't -- you know, I didn't -- I don't mean to get into confidential considerations.

JUDGE SMITH: I realize that.

MR. THOMAS: I am just trying to, you know, put in the record whatever connections this witness might have to the NRC. That was my only --

JUDGE SMITH: What is the nature of your consulting with OPE? Do you assist them in the drafting of adjudicative decisions?

THE WITNESS: No, no. I simply gave them technical advice. I did not -- on safety goals. I did not draft anything for them. --

JUDGE SMITH: Okay. Those safety goals have been published in draft form now.

Okay. Well, how far do you expect to go?

MR. THOMAS: Well, I -- that's probably as far as I will go.

I just basically wanted to see what the nature of the relationship was. That's all.

JUDGE SMITH: All right.

BY MR. THOMAS:

Q Do you have any other contracts or any other association with the NRC itself?

A I just recalled that I gave some lectures to the NRC Staff on probabilistic risk assessment, and in that connection I was a subcontractor to J. B. Fussle Associates. I gave a series of -- I don't recall the exact number -- perhaps four or five such lectures.

Q Can you tell us roughly the time period?

A Over the past 18 -- starting 18 months ago to six months ago, something like that.

Q Is that a continuing contract?

A No. It's over.

Q What about the consulting contract that you referred to earlier with OPE?

A It's still in force, but it's inactive. I am not doing any current work.

MR. THOMAS: A moment, please, your Honor.

BY MR. THOMAS:

Q Now -- excuse me a moment.

Now, on Page 6 of your testimony, the -- I guess it's the second full paragraph, you indicate, "It is useful to examine the question of why PRA studies are not and should not be required."

Do you see where I am referring?

A Yes.

Q Does that mean that the -- do you mean by that statement that the NRC licensing process does not consider specific risks to the health and safety of the public from Class 9 accidents?

A No. In fact, they do consider them in their FES documents; but they do not consider them in their safety licensing, the safety part of the licensing process; and I believe -- except in a few cases where they are considering them, I believe they should not.

MR. RAWSON: For the purposes of the record, may we know what the witness was referring to when he used the word "them" in the last couple of sentences?

THE WITNESS: The NRC.

MR. RAWSON: You said the NRC had not considered them.

Are you talking about PRA's?

THE WITNESS: Yes, PRA's.

MR. RAWSON: Thank you.

MR. GALLO: Mr. Chairman, counsel ought to

address his questions to the Board and the Board ought to decide whether or not the witness ought to answer the questions.

MR. RAWSON: I agree, Judge.

I was only trying to assist the record.

JUDGE SMITH: So there is nothing for us to rule on.

MR. GALLO: I was thinking in the future, your Honor.

BY MR. THOMAS:

Q Above that -- in the paragraph prior to that statement, it indicates that the logic structures described above permit consideration of, and then you have, "internal plant failures, pren, equipment failures, human errors in testing."

With regard to that reference to human errors in testing, does that include the assessment of errors in QA/QC during construction?

A No. This is meant to include operational testing; testing systems and components during operation of the plant.

Q Not during the construction stage?

A Not during construction.

Q Now, directing your attention to Page 7 and the first paragraph on Page 7, is it correct to say that the uncertainties that are associated with the estimates of

public risk at Byron have not been quantified?
A I guess the answer to that question is yes and no.
There has not been a full PRA done for the Byron plant.
The FES, on the other hand, has made a general estimate of public risks from the plant that I think represents a reasonable approach and has yielded conservative estimates of those risks.
Q Is that general estimate in quantitative terms, in your opinion?
A In the FES it is, yes.
Q And what is that general estimate based on?
A It's based on using a radioactive source term that has been established generically by the NRC to represent releases that might occur from large power reactors and then the use of a consequence model, using site specific meteorology and population distributions, to calculate public consequences.
Q Now, when you speak of the NRC deterministic process, for example, at Page 4, the last paragraph on Page 4, you indicate that it's called deterministic, in your opinion, because it is not probabilistic in nature; is that correct?
A Yes.
Q You also indicate that -- I believe that it rests on

qualitative engineering judgment as opposed to quantitative probabilistic estimates; is that right?

A That's principally correct, yes.

Q I take it, by "qualitative engineering judgment," you are talking, basically, about engineering opinion; is that correct?

A Yes.

Q Again, that is opposed to mathematical quantitative probabilistic assessments; is that correct?

A That's correct.

Q Now, on Page 8 you indicate, "It has also been demonstrated that the Reactor Safety Study has predicted essentially correctly events that have occurred, such as the accident at Three Mile Island 2.

What was the probability prediction for the TMI 2 accident?

A This statement means that the consequences -- the public health consequences -- that occurred at Three Mile Island, which were very small, were essentially within the scope of predictions of WASH-1400 as far as consequences are concerned; and that the probability of such consequences in WASH-1400 were somewhere between 1 chance in 400 -- and I am going on memory now, so these numbers may not be exact.

Q I understand.

A -- 1 chance in 400 to 1 chance in 40,000 per reactor year; and the measured frequency of that 1 event at Three Mile Island was 1 chance in 4,000 per year; but we did not analyze that explicit sequence -- that explicit accident sequence in WASH-1400, because we did not analyze a B&W reactor. We analyzed Westinghouse and GE reactors.

Q Well, I -- I don't mean to interrupt. Go ahead.

A That's all I was going to say.

Q Are you finished?

A Yes.

Q Are you drawing a distinction between the consequences and the occurrence itself?

A Not the occurrence of the consequences, but the --

Q I mean the occurrence of the events.

A -- the series of events was not predicted in WASH-1400, because it studied a Westinghouse reactor, which could not have had that sequence of events happening in that way.

Q Okay.

A Now, we studied a similar sequence. There was a similar sequence in WASH-1400, but of much lower probability because of the difference in design of the reactors.

Q With regard to the TMI 2 consequence, which, I think, you described as very small, upon what do you base that opinion?

A There were studies performed by the EP -- by an EPA-NRC

group -- I think it was called a task force, but I am not sure, and I think it's referred to in the Staff FES, which predicted somewhere in the neighborhood of a few thousand person rem as being the consequence of that accident

Q So you are basing that opinion on that study?

A Yes.

Q Were you involved in that study at all?

A No, but some of the people who worked for me were.

Q Okay. Have you been personally involved in any study of the consequences of the TMI 2 accident?

A You mean public health effects?

Q Yes.

A No, I have not.

Q With regard to the study which you spoke of, are you aware of problems with monitoring the consequences of the TMI 2 accident?

A Well, as in all measurements, you never have all the data you would like to have; but my understanding is that the conclusions of that study were supported by whatever data was available.

Q Do you know how many monitors were in place at TMI 2 at the time of the accident?

A No, I don't.

Q Are you aware of how many monitors are in place now at that location?

A No, I am not.

Q Now, you, on Page 9 of your testimony, discuss -- also discuss -- the Reactor Safety Study and then also the review group, the Lewis Committee Report.

Are you familiar with the Sandia study?

A Well, there are hundreds, thousands of Sandia studies.

Q I am talking about the Sandia study with regard to core melt accidents.

A Are you talking about the recent Sandia study --

Q Yes.

A -- which was called the siting study, which predicted very large consequences?

Q Yes.

A I am familiar with only a certain part of that study.

Q Which part are you familiar with?

A I am familiar with the part that resulted in the predictions of those very high consequences and the way in which those predictions were made.

Q Are you aware of the conclusion that the risk of a Class 9 accident was 1 in 100,000?

A That wouldn't surprise me. That's about the right number.

Q Do you know what sites were analyzed in the Sandia study?

A I think they looked at a large number of sites in the country, perhaps all of them; but I am not sure of the exact number.

Q Do you know if the Byron station or site is similar to any of the reactors used in the Sandia study?
A I don't know.
Q Do you know what the range of probabilities of Class 9 accidents were in the Sandia study?
A I think they went down as low as numbers of ten to the minus eight to ten to the minus nine per year.
Q Do you know if that, the range of probabilities in the Sandia study, was higher than the one in the WASH-1400?
A It's in the same range.
Q In your opinion, doesn't the Sandia study, by comparison to the WASH-1400, demonstrate that a generic PRA is not valid to assess the risk at a particular site?
A I would answer no; but I would like to qualify it by saying that you have to be sure, in making generic studies of that type, that they are close enough to being representative that they are not misleading and that they cannot give as precise results as if you did a PRA on a specific plant.
Q Okay. Now, when you state "generic studies of this type," were you referring to the 1400?
A No. I am talking about Sandia, the Sandia study.
Q How would you describe the WASH-1400?
A The WASH-1400 analysis looked at two reactors, one PWR and one BWR, and did, essentially, a full PRA on all the

engineering detail involved of those two reactors, predicted the probability of core melt, predicted the probability of containment failure and the various ways in which the containment would fail, analyzed the physical processes involved with molten fuel, analyzed the release of transport efficient products into the environment and their distribution in the environment, health effects.

Q All right. I wasn't asking --

A That is a specific PRA as opposed to a generic PRA.

Q Specific to an actual site or a composite site?

A Two actual reactors; but since our charter was to estimate the risks from the nuclear industry, we generated a composite site from all the sites in the country, 68 sites.

Q Would you agree that it's fair to describe your testimony here as basically generic testimony?

A I don't understand what that means.

Q Well, it's not really Byron specify, is it?

A I think it's specify to the contentions.

Q It's basically an explanation of the NRC process and why you believe it's deterministic as opposed to probabilistic in nature, don't you think?

A I think it covers that, but it covers much more than that.

Q Now, is it true that the Lewis Committee Report on WASH-1400 found errors in the analysis of liquid pathways;

specifically river site accidents?

A I guess I don't recall that.

The two reactors we analyzed were both on rivers. We did analyze liquid pathways.

I don't recall that Lewis found anything wrong with that; but I am not sure.

Q Are you aware that in this matter of Byron a March, 1983, letter from Com Ed to the NRC indicates that the -- that there is an error in the FSAR regarding the ungrouted rock transmicity values?

A No, I am not aware of that.

Q On Pages 16 and 17 -- this is related to what we were just talking about -- you say that in reaching a judgment on the adequacy of the Class 9 accident calculations reported in the Byron FES, you considered the following, and you list a number of considerations there; is that right?

A Yes.

Q As part of your evaluation, did you consider the adequacy of the methods employed in the FES in relation to the liquid pathways release to the environment?

A Not as carefully as I did those to atmospheric dispersion, because my general understanding from work I have done and work of others is that the liquid pathways contribute very little to public risk compared to the atmospheric dispersion and that's the conclusion reached by the FES

also.

Q Do you know what the conclusion in that regard is with regard to the Sandia Study?

A Sandia Siting Study?

Q Yes.

A No, I do not.

Q Okay. What -- when you say not as much, to what extent did you consider the liquid pathways release?

A Well, I read it casually, to see what conclusion they arrived at; and they arrived at a conclusion, confirming conclusions in WASH-1400 and other studies I have seen of that type.

Q But you are not aware at the present time recalculations are going on with regard to that subject?

A Recalculations of what by whom? I don't really understand the question.

Q Referring again to the transmissivity values of the ungrouted rock.

MR. GALLO: Objection. The witness has testified that he is not aware of the letter referred to by counsel. Therefore, he has no basis upon which to answer that question.

JUDGE SMITH: Do you wish to be heard on the objection, Mr. Thomas?

MR. THOMAS: No.

JUDGE SMITH: Sustained.

MR. THOMAS: I will withdraw the question.

BY MR. THOMAS:

Q All right. If at Byron there is an error in the FSAR on liquid pathways, what effect would this have on the FES conclusions regarding accident probabilities?

MR. GALLO: Objection. The question is vague. It seems to me that the witness has testified he is unaware of this error. Necessarily, the question if it's going to inquire into this further has to inform the witness of the area of the FSAR that he is inquiring about.

Indeed, he could give him a copy of the letter, upon which he could inform himself and then intelligent questioning and answering could follow.

The question is vague.

MR. THOMAS: I have no objection to tendering a copy of the letter to the witness, although -- well, I have no objection to doing that.

JUDGE SMITH: I can see the difficulty is going to be that you are going to have rather an unanalyzed event -- I mean circumstance, which, I assume, will later be clarified for our record; but you are going to ask him now to make testimony based upon a hypothetical.

MRS. JOHNSON: (Indicating.)

You are indicating no, Mrs. Johnson. All right. Just go ahead and see what happens.

MR. THOMAS: Let me see if I can put a more specific question based on the admittedly somewhat sketchy information that we have at this time.

BY MR. THOMAS:

Q For the record, you do have a copy in front of you of a March 11, 1983, letter from a T. R. Tramm of Commonwealth Edison to Harold Denton?

A Yes, I do.

Q Do you see in that letter in the second paragraph where Mr. Tramm indicates that there are -- that there is an error in the Byron Braidwood FSAR?

A Yes, I do.

Q And he further indicates that the ungrouted rock transmissivity values should be an order of magnitude higher?

A Yes.

Q Now, from that information, from the statement that they should be an order of magnitude higher, can you draw any consequences at this time with regard to the adequacy of the Class 9 accident calculations reported in the Byron FES?

A No, I cannot.

JUDGE SMITH: Did you intend to say, "can you

draw any consequences?"

MR. THOMAS: Any conclusions, I meant.

A (Continuing.) No, I cannot.

BY MR. THOMAS:

Q Is the reason that this transmissivity should be an order higher an inadequacy in the data base?

MR. GALLO: Objection.

A I am not sure how this is.

JUDGE SMITH: Dr. Levine, there was an objection.

MR. THOMAS: Yes, I withdraw the question.

JUDGE SMITH: Nevertheless, I would like to hear the question.

Would you read it back, Mr. Sonntag.

(The question was thereupon read by the Reporter.)

JUDGE SMITH: Do you understand the question?

THE WITNESS: I assumed the question -- when I answered the question, I assumed that it meant that: was this change in transmicity due to the fact that there was some inadequacy in the data to support it; and I said I don't know.

JUDGE SMITH: Is everyone happy with the question and the answer? I myself have lost track.

JUDGE COLE: Is the word transmissivity?

MR. THOMAS: Transmissivity.

THE WITNESS: I am sorry. I misspoke.

BY MR. THOMAS:

Q Assuming for the purposes of this question that the transmissivity values are -- excuse me -- transmissivity values are an order of magnitude higher, do you have an opinion as to whether the results predicted in the FES with respect to the possibility of liquid releases are still accurate?

MR. GALLO: Objection. The question is vague. It has not been established on the record just what the values are that the order of magnitude ought to be compared to.

Therefore, the witness can't possibly answer the question.

JUDGE SMITH: Well, now, as I understand the question, it's a hypothetical.

MR. THOMAS: Right.

JUDGE SMITH: And the weight -- I mean the evidentiary value of the answer will depend upon the accuracy of the hypothetical.

I don't know how he can do any better, given the state of the evidence as it is today.

MR. GALLO: Even as a hypothetical question, your Honor, the question is defective, because it asks in

a hypothetical sense to draw a judgment or a conclusion based on an order of magnitude relation to an unnamed numerical value. I don't know how the witness can possibly draw such a comparison.

JUDGE SMITH: I guess -- I think we better have the question back. Would you read it back, Mr. Sonntag.

(The question was thereupon read by the Reporter.)

MR. GALLO: An order of magnitude higher than what, your Honor? That's my objection to the question.

JUDGE SMITH: What did the author of the letter intend, is that what we are predicating the hypothesis on?

MR. THOMAS: Yes. Well, let me ask you this.

BY MR. THOMAS:

Q Do you know what --

JUDGE SMITH: Withdraw that?

MR. THOMAS: Yes, I will withdraw that.

BY MR. THOMAS:

Q Do you know what the transmissivity values are in the FSAR?

A No.

Q With regard to the previous question, can you answer that as to whether you have an opinion on that subject?

MR. GALLO: Objection. He is repeating the same question in another form and it's equally objectionable.

MR. THOMAS: I am repeating it but the question just asks if he has an opinion. If, in fact, what Mr. Gallo has put on the record here is the case, I am sure the witness can answer that.

MR. GALLO: Counsel is attempting to get his question asserted despite its legal deficiency on the plea that the witness maybe has an opinion on it nevertheless. That's not how jurisprudence works.

JUDGE COLE: Mr. Thomas, let me ask a question and see if it gets at what you are trying to get to.

MR. THOMAS: Sure, all right.

BOARD EXAMINATION

BY JUDGE COLE:

Q Dr. Levine, you looked at the estimates for liquid releases in the FES?

A I said I looked at them only casually.

Q All right, sir.

If the transmissivity values upon which liquid were at least partially based were increased by an order of magnitude, could that or would that change your estimate or evaluation of the impact of the liquid releases?

A I don't know without knowing the values and making an analysis.

It would certainly make the radioactivity move faster in the ground but faster might still be very slow.

I just don't know how to answer the question.

Q All right, sir.

But if anything would it constitute an increase or a decrease in the impact if it were to move faster through the soil?

A It would mean the radioactivity would get to water bodies faster than it might otherwise get there.

Q And is that generally associated --

A Unless there was some intervention taken to stop it.

Q All right, sir.

So in general is increased transmissivity associated with -- would that then be associated with possible incidences of higher doses to people if it were to lead to anything?

A It's potentially possible; but I would not agree that it would lead to those doses.

Q All right. I think we are talking about the same thing.

A Yes.

Q If it travels faster through the media, it gets to danger points quicker, wouldn't it?

A Quicker, yes.

JUDGE COLE: All right. Thank you.

BOARD EXAMINATION

BY JUDGE SMITH:

Q Is there another phemonenon at play if given a certain

amount of radioactivity, the speed with which it would travel would not change the total amount or the total doses unless you depend upon the decay during the transmission?

A There would be less decay, but there still might be adequate absorption in the rock to prevent it moving very fast, less fast than the water in the aquifer might. It's a fairly complicated situation.

BOARD EXAMINATION

BY JUDGE COLE:

Q Sir, do you know what the substrata is in the Byron area?

A No, I do not.

Q All right, sir.

In limestone or limestone-like dolomitic areas, are you familiar with some range of transmissivity values that might be associated with limestone or dolomitic areas?

A No, I am not. This is way outside my field of expertise.

JUDGE COLE: All right, sir. Thank you. I don't know whether that helps you, Mr. Thomas, or not.

MR. THOMAS: Yes, I think it is basically what I was trying to establish.

JUDGE SMITH: Of course, Dr. Cole was trying to help Mr. Thomas. I know you understand, Mr. Gallo, you continue your right to object, even though it's been put out as a Board question.

MR. GALLO: I understand that, Judge. Thank you.

BY MR. THOMAS:

Q Could the increased transmissivity values affect the FES calculation on Class 9 accidents as well as the FSAR?

A I don't know.

Q Could it affect the NEPA analysis on which construction license was based?

MR. GALLO: Objection. The witness has testified continually that he doesn't know about the details of this problem, that it's outside his area of expertise and it's fruitless and prejudicial to the witness to continue this line of questioning.

I would object and request that it be shutdown.

JUDGE SMITH: Well, I don't think that Mr. Levine is being harmed particularly by it.

However, your point is well made, that I think you have very well established what the reach of his expertise and what the reach of his testimony is.

BOARD EXAMINATION

BY JUDGE COLE:

Q Dr. Levine, his questions were prefaced by the word "could." You said you didn't know.

I believe you were answering "would it" and that's what you don't know; but is it correct that your answer to

"could it" would be you don't know?

A Yes.

JUDGE COLE: All right. Thank you.

JUDGE SMITH: Don't you agree, Mr. Thomas, you have rather well bounded his testimony, if that's your objective?

MR. THOMAS: Yes, I do. That was, again, the last question, I just wanted to outline the possible consequence or parameters of the recalculations that are going on with regard to the transmissivity values.

BY MR. THOMAS:

Q On Page 14 where in the second full paragraph, you were talking about or you were discussing 133 unresolved or generic safety issues at that time and you say, "these were examined by the use of probabilistic techniques and it was determined that only about 20 of these were of any direct safety significance."

Can you indicate what those 20 are or were?

A I don't recall now, but they are well documented.

Q Can you remember any of them?

A You know, [illegible] years ago. I just can't remember.

Q Okay.

JUDGE SMITH: Is that, generally speaking, the A Group?

A (Continuing.) Yes, it was. They mostly came from the A

Group. After this work was done, the distinctions between A, B, C and D were changed, I believe. They may have been re-established since then. I don't know.

BY MR. THOMAS:

Q On Page 17 I believe you indicate that larger values -- excuse me a minute.

You indicate that longer times for containment failure -- this is, I guess, the first full paragraph. -- you indicate that longer times for containment failure result in smaller releases.

A Yes.

Q Can you explain that?

A Yes. If you have radioactivity inside the containment that's airborne, it's reduced -- that amount of radioactivity that is airborne is reduced -- by one of several mechanisms. In fact, some of them operate at the same time.

If you have containment sprays running, they are reduced by some factor.

If you have the fan coolers running, they are reduced by some factor.

If you have neither of those running, there are natural deposition processes working and the longer all of those processes work, the more radioactivity will be deposited in water or on surfaces inside the containment.

So when the containment ruptures, there will be less radioactivity airborne available to lead to the environment. Those are all rate phenomena and they work as long as the radioactivity is there. So the longer the containment holds together, the longer they work.

BOARD EXAMINATION

BY JUDGE SMITH:

Q Without any operator action?

A Well, natural deposition is a physical phenomena depending on people. The spray systems and the fan coolers, I believe, are initiated automatically. Certainly the sprays are initiated automatically. I am not sure about the fan coolers.

Q So the additional time -- the point I guess I was inquiring about was: The additional time would also give additional time for operator action, too?

A Yes. If, for instance, the sprays or fan coolers did not operate initially and the containment were not to break and they came on later, that would be very helpful, if the operators were able to make them operable.

BY MR. THOMAS:

Q Now, on Page 18 of your testimony, you indicate that, in sum, the FES strikes a balance between conservatisms and uncertainties on the side of conservatism.

How do you know -- how do you -- strike that.

Why are you of that opinion, given the fact that the uncertainties have not been quantitatively analyzed for Byron?

A Well, in general, I have some knowledge of these uncertainties from other studies that have been made and they are generally dependent upon physical phenomena as opposed to specific details of the plant, although the details of the plant do affect them; but I believe that the overall conservatisms, especially with the time to containment failure which will strongly affect the fission product releases, are almost overwhelming in conservatism.

Q Now, on Page 19, when you are discussing the emergency core cooling system, you state that -- you are talking about a few of the relevant Byron design features and you state, "the emergency core cooling system is" -- you say it will "perform its design function with only one accumulator failed and with only one of the redundant trains of safety injection at the applicable pressure level."

Now, isn't it fair that the NRC requires the ECCS to operate with only one accumulator failed and with only one of the redundant trains of safety injection at the applicable pressure level?

A That's my belief, yes.

Q So, in other words, all plants are designed this way;

right?

A Essentially.

Q This is no -- this is nothing specific to Byron, which would increase safety margin over any other plant; right?

A That's correct.

Q With regard to your discussion of the safety systems in general, wouldn't you agree that based upon our experience, that safety systems are found -- are often found -- not to operate at the time that they are needed most? --

MR. GALLO: Objection. The question is vague, unintelligible.

As I recall, it said, "wouldn't you agree that safety systems, unnamed, based on our experience, unidentified, cause problems in terms that they won't operate," again, unidentified.

MR. THOMAS: That wasn't the question, but I understand the nature of his objection to the question.

Well, let me see if I can be more specific with an example.

BY MR. THOMAS:

Q Are you familiar with the problems of the failure of the reactor protection system breakers to open on demand, such as occurred at Salem?

A I am generally familiar with that, yes.

Q Are you aware that there have been approximately 35 incidents since 1973 in which one circuit breaker failed in an automatic safety system?

A I have heard numbers like that.

Q In light of these numbers, do you still feel, as you indicate on Page 19, that these protection systems make the probability of accidents characterized by failure to shut down the reactor very small?

A Yes, I do.

Q Why is that?

A Well, we have analyzed these systems. These systems have been analyzed in many -- several, I should say, PRA's and the numbers that have been predicted are probably in the range of what this experience has shown.

I have to say probably because I have not heard yet a reliable estimate of what this experience means quantitatively; but I would expect that quantitative experience to be in the range of what has been predicted.

BOARD EXAMINATION

BY JUDGE COLE:

Q When you say what has been predicted, what has been predicted by the WASH-1400 Study?

A And others.

Q And others?

A Yes.

Q All right, sir.
A Other PRA's.
JUDGE COLE: Thank you.
BY MR. THOMAS:
Q With regard to the safety systems and your discussion of the safety systems at Byron, we discussed -- well, the reactor protection system and the backup shutdown system which you have discussed, isn't that true as with the emergency core cooling system, that the NRC requires these design features?
A Of course.
Q Okay. And wouldn't you -- and the same thing with the containment building; right? --
A Yes.
Q And all of the safety systems that you discuss in your testimony?
A Yes.
Q And with regard to those safety systems, isn't it true that Class 9 accidents assume the loss of at least some of the safety systems?
A Yes.
Q So then wouldn't you agree that these safety systems are to some extent irrelevant in a discussion of Class 9 accidents, because, again, those accidents assume a loss of at least some of these systems?

A No, I do not agree.

Q And why is that?

A Well, may I give one example?

Q Sure.

A Let's assume you have a core-melt accident, say, arising from a pipe break and failure of the emergency core cooling systems to operate. You then have the containment; and while the containment is designed to a design pressure of about 50 pounds, it will not fail due to overpressure to something like two-and-a-half to three times that pressure.

While you have containment spray systems that are designed to remove radioactivity source terms for the design basis accident, they will work equally well with source terms from a core-melt accident.

So even though they are designed for handling accidents in which the core does not melt, they deal very effectively with accidents in which the core does melt.

Now, there is no set of combined equipment that can for sure prevent cores from melting and prevent radioactivity from being released, because anything can fail. It's a matter of the probability.

Q Now, with regard to the WASH-1400, you indicated that, in your opinion, the methodology used in that report is still fundamentally sound; is that correct?

A Yes.
Q And you also indicated that the Lewis Report said that the methodology was still fundamentally sound; right?
A That's correct.
Q But you would agree that the Lewis Report indicated that the numbers produced by the WASH-1400 are not necessarily reliable; right?
A Well, what they said was the uncertainties were greater than indicated in WASH-1400.
Q Therefore, that while the methodology may be sound, the actual numbers themselves are not?
A No. They said they couldn't determine what the right numbers should be but they felt the uncertainties were larger. I think that's a fair -- then we reported in our study -- I think that's a fair statement.

We did some work after we published the study, which did a little more rigorous analysis of uncertainties, and in fact we reported to the Lewis Committee that the uncertainties were larger.

They couldn't be very much larger in the upper direction, however, because if they were larger, we would already be seeing accidents of that type and we are not seeing them. So they couldn't be very much larger than they are now -- than reported.

JUDGE SMITH: Would you repeat your last phrase

following "but"?

A (Continuing.) They couldn't be very much larger than reported. I am sorry that I mumbled.

BY MR. THOMAS:

Q Or, you say, we would be seeing accidents now?

A Yes.

Q Well, does that necessarily follow from a probability estimate that they couldn't be larger on the upper end or we would be seeing them now?

A If the probabilities were much larger than we reported, such accidents would be occurring because of the number of reactor years of operation.

Q By "such accidents," are you referring to core-melt accidents?

A Yes. I am just saying there is some limit to how far off we could have been on our uncertainties in the upper direction. Lewis has said publicly he thinks we were conservative and that our estimates should have been lowered, our estimate of core melt probably should have been smaller.

Q Is it true that you -- strike that. No.

Is it true in January, 1979, the NRC stated that it did not regard as reliable the WASH-1400 numerical estimate of the overall risk of reactor accident?

A Yes, that's true.

Q And is it true that in the same month the NRC issued a formal statement of policy disavowing the Rasmussen Report accident probability estimates as not reliable?

A Yes.

MR. THOMAS: Your Honor, I am sorry. Would this be a good time for the morning recess?

JUDGE SMITH: Yes, if it's satisfactory to you.

MR. THOMAS: Yes.

JUDGE SMITH: All right. We will take our mid-morning recess of 10 minutes at this time.

(Recess.)

JUDGE SMITH: Mr. Thomas.

BY MR. THOMAS:

Q In your testimony regarding the consequences of Class 9 accidents, did you take into account the role of emergency planning considerations at all, such as evacuation?

A Yes, they were taken into account in WASH-1400, and they are taken into account in later versions of the consequence model.

The consequence model in WASH-1400 was called CRAC. There is a newer model called CRAC 2, which is used these days; and this takes into account evacuation scenarios for the public in the vicinity of the nuclear power plant; and the kinds of studies that are being made to plan evacuations as needed are yielding results similar to the

CRAC predictions, CRAC 2 predictions.

Q So then -- okay.

When you say you took it into account, you mean in the sense that you discussed these studies, like WASH-1400?

A The way the evacuation planning in CRAC and CRAC 2 were developed was based on a study of real world evacuations that had occurred in the U S.

There was a study done by EPA -- I can't recall the name of it -- and the data in there, in that study, furnished the basis for the CRAC evacuation model, and a reinterpretation of that data resulted in some improvement in the evacuation model in CRAC 2.

Q All right. What real world evacuation was taken into account?

A Such things as toxic chemical releases from train crashes, floods, are all I can recall. There may have been other things.

There were no nuclear power plant accidents --

Q Yes, right.

A -- in the data base.

Q Were any of the evacuations on a scale -- did any of them deal with evacuations of a population density such as Metropolitan Chicago?

MR. GALLO: Objection; irrelevant.

JUDGE SMITH: Overruled.

MR. THOMAS: Do you remember the question?

THE WITNESS: The objection is overruled?

JUDGE SMITH: Yes.

A I can't recall.

I do know that the data -- I do recall that the data covered various population densities for numbers of people that had to be moved, and it also showed that the higher the density of people, the faster they could be removed; but I don't know -- I don't know how high that number went.

BY MR. THOMAS:

Q So you don't know if any of them dealt with a density such as I said, Metropolitan Chicago?

A I don't know, but I would doubt it.

Q Do you know the basis for what you say was the finding that the higher density, the faster the people could be removed?

A Yes. It was basically that in higher density populations there are better road systems to allow the people to move faster.

BOARD EXAMINATION

BY JUDGE COLE:

Q Doctor, that conclusion, when they say moved faster, are they talking about number of people per hour or the

percentage of the population or what?

A The number of people per unit time could be moved faster, you could move more people per unit time.

Now, I would say -- I would have to say that I read that report many years ago, and it's very vague in my memory, and I may be stating some small errors of fact, but the general impression I can give you is correct.

Q I wonder of what value that statement is if we still have a larger percentage of the people remaining. Even though we can move them out faster, move them at a faster rate, there are so many more to move out, it doesn't tell me anything.

A Let me tell you what the analysis of the data showed, in our opinion, in the original CRAC evacuation model and the current CRAC 2 evacuation model.

In the emergency CRAC evacuation model, we assumed that approximately 30 or 40 percent of the time people did not move at all. They just sort of moved around but didn't have a net velocity away from the cloud; and 30 or 40 percent of the time they moved with a very low velocity of 1.2 miles per hour and the remaining time they moved with 7 miles per hour evacuation speed.

The latest model reinterprets that model into the delayed times of starting, with 1, 3 and 5 hours, and then moving with a constant 10 miles-an-hour velocity, so

that's the way the data was interpreted.

JUDGE COLE: All right, sir. Thank you.

BY MR. THOMAS:

Q When you say -- you used the word "our, our calculations." Whose calculations were you referring to there?

A When I said "our," I was talking about the CRAC model, which was developed as part of WASH-1400.

Q Okay. To your knowledge, has there ever been an evacuation in this country on the scale required to evacuate Metropolitan Chicago?

A I don't know, but I doubt it --

Q Okay.

A -- but I am not sure that Metropolitan Chicago would have to be evacuated in the case of a reactor accident.

Q Well, that's --

A I am quite sure it would not have to be.

Q Well, there is certainly some Class 9 accident scenarios where it would have to be evacuated, wouldn't it?

A There might be required, in some very, very remote cases of rain, the movement of some people, but not in a few hours. Perhaps in half-a-day or something like that.

Q All right. Half-a-day.

Are you of the opinion that Metropolitan Chicago could be evacuated in a half-a-day?

A I am not suggesting that Metropolitan Chicago would have

to be evacuated. That's your term, not mine.

Q If it did, do you think it could be done?

JUDGE SMITH: Mr. Gallo, when we overruled your objection on relevance, we didn't mean it to pertain to any and all references to evacuating Chicago. I just wanted to make that clear.

I am not suggesting that you object now.

MR. GALLO: Would you entertain an objection, your Honor?

The witness is answering the questions. I will stand by his answer.

MR. THOMAS: Judge, surely you are not worrying about intimidating Mr. Gallo.

BY MR. THOMAS:

Q Are you familiar with the Byron emergency plan?

A No, I am not.

Q Are you familiar with modifications currently -- that that plan is currently undergoing?

A No.

Q The population density estimates which are contained on Page 16 of your testimony, you have no idea if those are accurate, do you -- the bottom of Page 15, the top of Page 16?

A I am quite sure that the Byron population density, as stated here for distance out to 50 miles, is less than the

average of 111 sites.

Q Well, are you aware that this is a recreational area and it has quite a large temporary population of people who use recreational facilities?

A I am not sure whether that is included in these numbers or not. I suspect not.

Q In other words, again, you have not made any independent analysis on your own of the demographics situation?

A I have taken numbers generated by other people; by the NRC, in fact.

Q Do you know why -- in compiling the demographic statistics for all nuclear sites, do you know why the NRC has used average rather than median to make a decision on whether the Byron site is a high density population area?

A No, I don't.

Q Now, on Page 25 and Page 26 of your testimony, where you are talking about using precursor events to help improve the predicted probabilities of accident sequences, I think that you indicate that, in order for these figures to be anything less than ill-defined or murky, they have to be plant specific; is that correct?

A If you are trying to draw conclusions about the probability of specific accident sequences, yes.

Q Now, again, in the sense that WASH-1400 dealt with the composite sites as opposed to plant specific

considerations, would you describe it as ill-defined and murky?

A Not at all, because we did define specific accident sequences for specific plants.

Q But you would -- but based upon composite sites?

A That has nothing to do with the argument.

Q Why is that?

A Because the engineering aspects of the plant, which are defined in accident sequences, do not involve the consequence model or the site considerations, the site meteorology or the population distribution or anything else.

Q Then in terms of accident consequences, though, that's where composite were involved in WASH-1400, population densities and so on?

A In predicting consequences, yes.

Q Would you characterize those, the WASH-1400 conclusions regarding accident consequences, as ill-defined and murky for that reason?

A No; but certainly they would not be applicable to any one reactor site.

MR. THOMAS: If I might have a moment, your Honor, I think I am largely finished.

JUDGE SMITH: Off the record for a moment.

(There followed a discussion outside the

record.)

JUDGE SMITH: On the record.

Mr. Thomas.

BY MR. THOMAS:

Q Are you familiar with the conclusion of the Sandia Site Study regarding the relationship of the melt-down categories found most probable by WASH-1400 in relationship to the liquid pathway releases?

A I don't understand the question.

Q All right. Are you aware that the study found that the most probable WASH-1400 melt-down categories resulted in the highest liquid pathway releases?

A The highest --

Q WASH-1400 --

A Yes, yes.

Q Okay.

A Excuse me. I am not aware of what the Sandia study said; but if that's what it said, that's true.

Q Okay. You would agree with that statement then, regardless --

A Yes; but the releases would be very small, in any event.

MR. THOMAS: Those are all the questions I have of the witness at this time, your Honor.

JUDGE SMITH: Mr. Rawson.

MR. RAWSON: Judge, I believe DAARE/SAFE has

questions on this contention.

MR. THOMAS: Judge, DAARE/SAFE has a contention in --

JUDGE SMITH: There is no lead?

MR. CAMPBELL: There is a lead intervenor, your Honor.

I just wish to ask some follow-up questions that I feel that were not covered by the League.

It does not pertain per se to any one specific thing. I just wish to ask follow-up questions specifically concerned with DAARE/SAFE's contention that I feel that he did not --

MR. THOMAS: I really didn't dismiss the consideration from the ring of nuclear plants that DAARE/SAFE's contention addresses.

JUDGE SMITH: Do you have a -- do you have a cross examination plan?

MR. CAMPBELL: No. This would just take in, again, follow-up.

JUDGE SMITH: Okay.

MR. GALLO: Mr. Chairman -- excuse me, Judge. I just was handed a note about an emergency phone call. I wonder if we could take five minutes while I make it.

JUDGE SMITH: Yes, surely.

MR. GALLO: Thank you. I appreciate it.

(Recess.)

MR. GALLO: I appreciate the indulgence of the Board and the parties.

Thank you, your Honor.

CROSS-EXAMINATION ON BEHALF
OF INTERVENOR DAARE/SAFE

BY MR. CAMPBELL:

Q Mr. Levine, are you expensive?

MR. GALLO: Objection.

JUDGE SMITH: Sustained.

BY MR. CAMPBELL:

Q Is your testimony -- have you ever testified for intervenors before?

A No; nor am I doing it now.

Q Is that to mean that if your testimony -- or if there was something you wanted to say -- that you had to say that would help the intervenors, you would not say it?

A I would say whatever I believed to be the truth, sir.

Q Whatever you believed to be the truth?

A Yes.

Q Even if it went against your clients?

A Absolutely.

Q Is one of the reasons you never testified for intervenors because your testimony usually does support the improbability of accidents occurring?

MR. GALLO: Objection.

My understanding is that DAARE/SAFE was going to conduct a cross examination of a non-cumulative type.

This is cumulative cross examination going to the bias point, explored at length by counsel for the League of Women Voters, and, therefore, it's improper cross examination.

They should be limited to their Contention 2 a.

JUDGE SMITH: I don't see why the bias of the witness, which is virtually an ideal subject matter to be covered by the intervenor -- it has equal applicability to both intervenors as compared to a contention-specific issue.

You could have worked it out with Mr. Thomas.

If you represent to the Board that, simply, you forgot or something else, that would be one thing; but the Board did not issue an order requiring this procedure because we inferred from the stipulation that you would follow the procedure of putting all of the joint cross examination in the hands of a single intervenor.

Now, if you feel at a disadvantage, we might want to make an exception for this particular time, but caution you for the future, unless you have a contention-specific issue that cannot be covered and is not covered by the lead intervenor, that you cannot have additional cross

examination.

Let me see what the Board's preference is.

The Board is split, and in that case, we were ruling on the majority, and that is we will admonish you that in the future you have to have general questions pertaining to all of the contentions and all of the interests of the intervenors in the hands of the lead intervenor, unless there is an internal problem, which we can't perceive now, that makes that impossible. If there is a failure of cooperation, then you can represent that.

Are you having trouble with the lead intervenor approach?

MR. CAMPBELL: Not up until -- this one contention, I would say, would be the only chance out of all the contentions presented by DAARE/SAFE and the League that we would, perhaps, have differing opinions about in perceiving --

JUDGE SMITH: Are you representing to us there is a difference of opinion among the intervenors on this approach?

Well, we are going to allow you to go anyway.

MR. CAMPBELL: Thank you.

JUDGE SMITH: But it would be for a greater reason, if you had represented there is a difference of opinion.

After this, that is one of the elements that you will have to establish for separate -- you consult with Mr. Campbell -- that will be one of the elements that you will have to establish before you can have separate intervention.

MR. CAMPBELL: Your Honor, it would be that in the future that I am sure there would never be another time in which we would have this.

JUDGE SMITH: All right.

MR. CAMPBELL: We just right now are trying to present some of our viewpoints and get Mr. Levine to answer some of our questions that we felt important.

JUDGE SMITH: Ms. Chavez.

MS. CHAVEZ: Your Honor, there is just one point that I would like to request clarification from the Board on, and that's that in the future on some other contention, if we find it difficult -- and it is going to arise -- to make a distinction between some points that Mr. Thomas has brought up in his cross examination and some points that would relate more specifically to our contention, that we be able to bring in this information, because it is not possible to always make such a clear distinction between questions that pertain to our contentions and questions that pertain to his.

JUDGE SMITH: We will take that up on a

case-by-case basis.

However, the point is, that you don't understand, you first have to make your best effort to feed your questions through Mr. Thomas, best effort.

If that doesn't work, then we will -- or whoever is representing the joint Intervenors.

If that doesn't work, we will allow you to go separately.

So, although the objection is well made, as a matter of Board discretion, we overule it.

MR. GOLDBERG: Judge, let me make one statement relative to Ms. Chavez' statement.

All parties entered into the stipulation which they agreed would govern the presentation of evidence and the conduct of the proceeding.

I would add this as background; that that was voluntarily understood that they would approach the case with the lead intervention concept.

JUDGE SMITH: Yes; but the lead intervention concept also assumes that all issues can be handled by a lead intervenor.

The overriding regulation is that -- the overriding approach is that the party should not be required -- well, in any event, we discussed it enough, and I see good faith in all parties involved and I don't see a continuing

problem.

I might observe: We have been permissive to the utility itself in allowing more than one counsel address the same issue. I don't see anybody being prejudiced.

MR. CAMPBELL: I can't remember.

Was there a question that was pending?

JUDGE SMITH: Well, the question was, is the reason that he has not testified on behalf of intervenors is because he usually testifies in a manner, presumably, which you perceive his testimony today to be.

I think I restructured your question somewhat, but that's the gist of it.

Do you understand the question?

THE WITNESS: I can answer, yes.

A I have never been asked to testify by an intervenor.

BY MR. CAMPBELL:

Q Have there been risks associated with the operation of nuclear power plants? In the last 20-some years, have there been risks associated with the operation of nuclear power plants?

A There are risks inherent in any activity in which man engages.

Q And these risks have been more or less quantified in WASH-1400?

A Yes. The risks have been quantified for large light water

cooled reactors, no others.

Q Could you -- especially for the public, could you state what the risk is that has been quantified by WASH-1400?

A Well, they are presented in WASH-1400.

We have calculated the probability of early fatalities of various sizes. We have calculated latent cancer fatalities as a function of probabilities. We have calculated property damage. We have calculated genetic effects. We have calculated thyroid nodules and thyroid cancers.

We find that all of these -- almost all of these are very small compared to the risks that people normally are exposed to.

The only health effect we calculated that would be noticeable would be thyroid nodules at very low probability. The number of thyroid nodules that would occur, a probability of ten to the minus nine per reactor year.

Thyroid nodules are not a serious illness. They are annoying and painful but not debilitating.

Some of them are cancers, and some of those cancers cause fatalities, and those are accounted in the latent cancer fatalities.

The latent cancer fatalities were predicted are a very small fraction of cancer fatalities that would

ordinarily occur.

The acute fatalities that are predicted are much lower in probability than those from other kinds of accidents in society, and no larger, and sometimes smaller, than those that occur from other of man's activities.

Q You say 10.9 per reactor year?

A I don't recall using that number.

Q Ten to the minus nine?

A Ten to the minus nine, one chance in a billion, per reactor year for these large consequence, which are still smaller than things that are occurring every day.

Q That is what I was wondering.

One chance in a billion, does that mean one chance -- if there was a -- if there were a billion reactors operating in the United States, you would have one major accident every year; is that -- I want --

A Something like that, yes.

Q But there are only 100 reactors operating.

A Well, the best way to look at it is the chance per year of reactor operation, which is the way we quote it.

Q Did you go into the chances of other accidents happening that were not Class 9 accidents or that were Class 9 but that were not related to a worst scenario?

A Yes, we looked at a whole set of accident spectrums,

accident scenarios, with differing probabilities and differing consequences; and, as in all accidents, such as automobile accidents, you find a variety of probabilities and a variety of consequences.

If you look at automobile accidents, the number of paint scrape or bent-fender accidents is much larger than the number of accidents that total your car or kill you.

So there is a spectrum of accidents in automobiles and there is a spectrum of accidents in reactors.

Q Okay. So you have -- WASH-1400 did indicate that there could be some accidents and put numbers on those chances of accidents happening?

A We estimated the probabilities by logical methods using data on component failures and human errors and things such as that.

So we estimated the probability of occurrence of the accident scenarios, we estimated the magnitude of the radioactive releases associated with those accidents and we estimated the health effects of those accidents, all done probabilistically.

Q That was in your testimony in answer to Mr. Thomas' questions before about the WASH-1400 predicting more or less that Three Mile Island?

A They were predicted because they have not happened.

Q I mean the Three Mile Island accidents, the accidents on

Three Mile Island happened --

A Well, when Three Mile Island happened --

MR. GALLO: Excuse me. We can't have both the questioner and the witness talking simultaneously. The reporter only can get one. So we have to let each individual finish. Otherwise, the record will not be clear at all.

MR. CAMPBELL: I am sorry.

BY MR. CAMPBELL:

Q The chances of an accident happening similar to Three Mile Island was listed in WASH-1400, I believe you stated, 1 chance in 4,000?

A No. That was the frequency of occurrence of the accident at Three Mile Island, because there were, at the time it happened, 400 reactor years, and that comes out to be about two times ten to the minus three for the frequency of the accident.

What I said was the Westinghouse reactor does not have an accident of that type, cannot have an accident scenario of that type; and that -- however, the consequence associated with the Three Mile Island accident, which was a few thousand person rem, represented a point on our consequence curve that was calculated in WASH-1400 that had a frequency between 1 in 400 and 1 in 40,000. So the 1 in 4,000 was within the range of

probabilities that we predicted for an accident of that size.

Q The consequences of a degradated --

A I should say that a few thousand person rem -- excuse me -- means that it is a small chance that one person might die as a result of having a cancer from that kind of an accident.

Q They can't pinpoint that one person, though; is that correct?

A Cannot pinpoint that one person, no.

Q The consequences of the accident, though, was the degradated core, a two-and-a-half million dollar reactor that looks like hamburger.

What are the chances --

A The core is severely damaged.

Q What are the chances of another degradated core accident?

A I think they are significantly lower than that at Three Mile Island because of the kinds of improvements that have been made in reactors and because of the improvements made in reactor training -- in reactor operator training.

Q So is there a new figure as to the chances of another degradated core occurring?

A I don't have a new number.

It's very hard to calculate such numbers with WASH-1400-type methodology.

WASH-1400 predicted accidents that were not core melt or that resulted in core melt.

To predict accidents that fall in between that are very difficult. People are working on that now, but there is no established methodology for doing that.

Q Would you consider --

A It seems more profitable to analyze reactors and find out what you have to do to decrease those probabilities than to predict them.

Q Would you consider Fermi, the Fermi reactor, a degradated core accident?

A The Fermi 1?

Q Yes.

A Oh, yes, they melted parts of three fuel elements.

Q Would you say that once every ten years we could expect a degradated core accident?

A No, I wouldn't, because the Fermi reactor was a fast breeder reactor and bears no relationship to large water-cooled reactors.

Q Well, then with Three Mile Island occurring, say, 20 years after the beginning of nuclear power, would you say that once every 20 years we could expect a degradated core accident?

A It depends upon how many reactors are operating; but I think that, as with all of man's endeavors, you learn from

your analyses, you also learn from events that have happened, and you take corrective measures that make those things less likely to occur.

Q Well, there is some discussion, isn't there, that -- whether the TMI 2 action plan requirements are being implemented?

A I think they are being implemented. You may question the time scale at which they are being implemented.

As, again, with all of man's endeavors, things have to be implemented on a practical time schedule.

Q Practical meaning profitable?

A No. It means availability of funds with which to do them. It means the number of people onsite, the number of things going on in the plant at one time.

I think you have to use rational judgments in making these. Some of the fixes are more important than others, some take longer times to procure necessary equipment, et cetera.

The most important things, which were improving the training of the operators and improving procedures, have been already done. Those are the most important thing, in my opinion. They are already done.

Q Of the 347 post-TMI 2 action plan requirements, do you know how many have been completed?

A No, I do not.

Q If I said 236 have not been completed by January of this last year, and of those, 123 were of the highest priority, would you say that that could be?

MR. GALLO: Objection. I think the line of questioning that Mr. Campbell is pursuing is really immaterial to the issue at hand here and, therefore, is not probative and should not be allowed, and I object to any further questioning along that line.

MR. CAMPBELL: My next question would pertain directly to Byron and I would ask then how many of these have taken place at Byron, have been implemented.

JUDGE SMITH: Well, the evolution of the questions and answers that we got here was the fixes learned, the lessons learned, will reduce the frequency of severe accidents, core-melt accidents, and that was relevant and appropriate, and now he is bringing in the factual question as to whether the lessons learned are implemented.

Let's consult.

The form of your question may be difficult but the subject matter of your question is appropriate.

Read the question back.

We are overruling the objection based in part upon your representation that your next question will be

relevant specifically to Byron and the contention.

(The question was thereupon read by the Reporter.)

A Anything can be. It depends. I have no way to know whether it's right or wrong and I am willing to accept your word, however. I don't know.

BY MR. CAMPBELL:

Q Do you know how many requirements have been implemented at Byron?

A No. I am aware that some things are planned to be implemented. I don't know if they have been implemented.

I have no idea what the total number is.

Q Are you -- you are familiar with some of the implementations then at Byron?

A Yes, some of the things I covered in my testimony.

Q I am still not sure whether I ever did get a number, an idea of when you think the next degradated core accident could occur.

A I told you I didn't know. I have no way to predict it, except I am sure it's lower than the frequency at which TMI occurred.

Q In the WASH-1400 Study, and especially on Page 8, the bottom of the page, you stated that there are two specific reactors for the WASH-1400 Study.

Could you tell me, first of all, who analyzed the

two specific reactors for WASH-1400, NRC Staff or someone else?

A It was not the NRC Staff. It was a group of people put together under the direction of Professor Rasmussen. It included a few employees of the NRC, then AEC Regulatory Staff, it included contractors of various kinds from national laboratories and companies and they were under the general direction of myself and Professor Rasmussen.

This group had total discretion on what it was doing. No one directed this group other than Rasmussen. It was funded by first the AEC and then the NRC; but there was no direction given to the group, other than the general charter, which I have outlined.

Q The general contractors, did they come from the industry?

A Almost none came from the nuclear industry. I think we had one person who was employed by an architect engineering firm. Most of the people not AEC employees, came from aerospace, national laboratories and some came from the aerospace industry.

Q Is Byron comparable to either of the two reactors?

A Well, Byron is a pressurized water reactor and one of the reactors we looked at was a pressurized water design. I am sure there are differences in design. In fact, I know there are differences in design between the two reactors.

Q Is it a lot? The difference, is there an enormous amount

of difference?

A There are some significant differences, and I can't quantify it beyond that.

Q What was the size of the PWR?

A It was in the neighborhood of 800 megawatts electric, but we -- when we analyzed the consequences of accidents, we assumed it had a fission product inventory as though it were a thousand megawatt reactor.

Q Was this a Westinghouse reactor?

A It was a Westinghouse reactor.

Q You are familiar that Byron is a Westinghouse reactor?

A Yes, I am.

Q There is a short technical appendix to the WASH-1400 that demonstrated that only a few people might be killed.

Is there a specific name for that appendix?

A I am not sure what you are talking about.

JUDGE COLE: You are not talking about the executive summary?

MR. CAMPBELL: No. It was an appendix talking about how many people would -- might be killed.

A (Continuing.) Well, that was covered in the main report, Appendix 6 and Appendix 11.

BY MR. CAMPBELL:

Q Did it come up with a result, did the WASH-1400 come up with results as to what would happen in a Class 9

accident, the worst-case scenario?

A Yes. I have already outlined to you what those results were.

Q The number of people killed?

A Well, I haven't given numbers. Would you like me to give numbers?

Q If that would be --

A Yes. In the worst case, for the worst accident we examined in WASH-1400, with a probability of one chance in a billion per reactor year, there will be 3,300 early fatalities, 45,000 latent cancer fatalities and 14 billion dollars worth of property damage. I don't remember the other numbers. I am sorry.

And I would like to say that we presented comparison curves and tables in WASH-1400 which shows that these numbers were no longer than and in many cases smaller than fatalities and property damage that already occur in society every year -- well, that already occur in society. Strike, "every year."

Q I am sorry. What was that?

A I struck, "every year."

Q Okay. The Sandia Study came up with revised figures and even site specific figures for Byron, did it not?

MR. GALLO: Objection. Judge Smith, I have sat patiently while Mr. Campbell has questioned at length and

run over essentially the same ground that Mr. Thomas ran over with respect to WASH-1400.

Now, I anticipate a repetition of the questioning on the Sandia Report.

I thought the purpose of this cross examination was limited to Contention 2-A and I have yet to hear one question specific to that contention.

I object to any further questioning by this questioner with respect to the Sandia Report on the grounds that it's cumulative and not probative and, therefore, not proper cross examination.

MR. CAMPBELL: I don't believe that it has been mentioned anywhere the site specificity of the Sandia Report to Byron, something which should be put in the record and something that the public should be well aware of.

MR. GALLO: I don't know if that's true or not, your Honor.

All I know is that Mr. Thomas asked a number of questions about that report and the record will show whether or not this piece of information was listed.

The point is, the opportunity was presented to Intervenors and what we are --

JUDGE SMITH: We have already ruled on whether we will allow this Intervenor to cross examine.

How do you distinguish between this and the --

MR. GALLO: Well, I didn't -- I am sorry.

JUDGE SMITH: Go ahead.

MR. GALLO: I didn't understand the Board's ruling as to mean that, essentially, this Intervenor had latitude to reproduce and cover the same ground as Mr. Thomas already covered.

JUDGE SMITH: That's true.

MR. GALLO: I only understood the Board's ruling to mean, with respect to the issue of bias, he was permitted to cover the same ground.

Now, I listened patiently while he covered the same ground on WASH-1400. I have reached the end of my patience. He now wants to pursue the Sandia Report. I think it is a breach of the stipulation that was signed by all parties, and is beyond the proper discretion that this Board should permit.

JUDGE SMITH: Your contention is cumulative effects?

MR. CAMPBELL: Yes.

JUDGE SMITH: And little about your cross examination has been on cumulative effects.

MR. CAMPBELL: I was going -- and, again, I thought that I was going over some of the testimony that was presented wishing to bring out, flesh out, some of the

testimony. There were questions I felt that were not raised.

Then I would continue on and ask specifically the cumulative effects. Now --

JUDGE SMITH: Is it your view that you can't get into the cumulative effects until you flesh out the effects of the operation of Byron?

MR. CAMPBELL: Yes. And then I will be continuing on to ask about whether the effects of the number of plants that are surrounding Rockford --

JUDGE SMITH: It does seem you are tracking very closely the cross examination of Mr. Thomas.

MR. CAMPBELL: I thought that I was allowed to do that. What I am doing is asking him the questions that I felt that he did not, again, flesh out, that I wanted specific things to be brought out into the testimony that would relate then to the cumulative effect.

JUDGE SMITH: All right. Is there any further discussion?

(No response.)

JUDGE SMITH: The Board's ruling is, in effect -- I think, perhaps, you picked the wrong particular question to object on; but the question is so specific to the contention as a whole and to the issue as a whole that we will permit the answer.

MR. GALLO: May we have the question repeated, your Honor?

JUDGE SMITH: Please, Mr. Sonntag.

(The question was thereupon read by the Reporter.)

A I don't know for specifically, but I know they calculated almost every site in the country. I wouldn't call them revised figures. I would call them a different estimate but, in fact, the numbers published in the Sandia Study are quite small compared to that which Congressman Marquis obtained from the computer printouts and made public. So we have to decide whether you are talking about the Sandia Study report or the computer printouts that caused all the furor.

MR. CAMPBELL: It would be the computer printouts, that was my mistake, that did indicate that there would be a number higher than those. I was just wondering if you were familiar with the figure given for Byron specifically.

A (Conrtinuing.) No, I am not, but I would not agree with it in any event, because I know that the methodology used to calculate it is highly questionable, in fact, engine correct.

BY MR. CAMPBELL:

Q You would stick to the WASH-1400 Study of 14,000 -- 3,300

early fatalities?

A I would accept as a reasonably -- a reasonable approach to estimating the consequences of accidents, Class 9 accidents, at the Byron site for the Byron reactor, the general approach used by the NRC Staff in its FES.

JUDGE SMITH: Excuse me. Going back to WASH-1400.

THE WITNESS: Yes.

BOARD EXAMINATION

BY JUDGE SMITH:

Q You are on the implied issue now of the worst-case scenario and I think you -- should we infer from your testimony that WASH-1400 in its case, in its worst-case analysis, assumes protective actions?

A It assumes some evacuation course, as I described earlier. If that's what you mean by protective actions.

Q Yes. And the Sandia Report did not, as I understand it, that you are referring to?

I am trying to focus on --

A The Sandia Report --

Q -- The basis of your sharp difference.

A Yes, I understand the question.

The Sandia Report in cases of extremely low probability estimated that a rain -- it could rain and wash radioactivity from the airborne cloud onto the

ground; and this would be far from the reactor, tens of miles from the reactor, beyond ten miles from the reactor; and that the people in that rained-out area would stay there for 24 hours.

Q Outside?

A Outside. And I think that's an irrational calculation. I don't believe that would happen.

I believe that actions would be taken to remove the people or get them inside; and if some action like that were taken in 12 hours, none of those people would die.

I can't believe that if such an event were to occur, even at that very low probability, that the people would not move.

Q I don't want you to go too far in response to my question. I just wanted to focus on the sharp distinction that you saw.

A That's the distinction.

BY MR. CAMPBELL:

Q It is interesting to note that Commonwealth Edison would rather shelter the people --

A Sheltering --

MR. GALLO: Objection. It's a statement, not a question and it's irrelevant to the contentions.

MR. CAMPBELL: I wasn't finished with my question.

JUDGE SMITH: Do you want to start again? The Board was conferring when the question began and start fresh. Instead of reading it back, start fresh with your question.

MR. CAMPBELL: I am sorry.

BY MR. CAMPBELL:

Q Are you familiar with the plans, evacuation plans of Byron, that they would rather shelter the inhabitants instead of move them out?

A No, I am not.

MR. GALLO: Objection.

JUDGE SMITH: Wait a minute. You don't have to -- if he disagrees with the premise or he doesn't know what the premise is, he can state that's the case.

MR. GALLO: All right. I will withdraw the objection.

THE WITNESS: I am prepared to answer the question, Judge.

JUDGE SMITH: All right. You may answer.

A I am not familiar with that detail.

However, sheltering would be as effective as removing the people in this case.

BY MR. CAMPBELL:

Q Repeat early fatalities for Byron, scaled for Unit No. 1 --

A I am sorry. I can't hear you.

Q Peak early fatalities for Byron at Unit 1 is listed as 9,050.

MR. GALLO: Objection. I don't know what he is reading from. There is a predicate to the House --

MR. CAMPBELL: That is the U. S. House Interior Subcommittee on overestimate investigations of calculation of reactor accident consequences.

MR. GALLO: If Mr. Campbell wants to take the stand and offer that into evidence as his testimony, I will cross examine him on it. It's improper cross examination.

MR. CAMPBELL: That is the Sandia Report, though.

JUDGE SMITH: Pardon?

MR. CAMPBELL: That is the Sandia Report, though.

MR. GALLO: The Sandia Report has not been marked as an exhibit or offered into evidence in any way. All of these questions on the Sandia Report simply elicit whether or not Mr. Levine is aware of this or aware of that. It's a memory contest. We have not introduced one iota of probative evidence from the Sandia Report through this cross examination.

JUDGE SMITH: I am aware the difficulty is we are taking the matter up a question at a time and an

objection at a time. Let's address the basic tension between the parties.

You are going to, apparently, attempt to cross examine Mr. Levine extensively on not the Sandia Report but the computer printout worst-case data.

Counsel objects. He objects primarily because you are assuming that the report is in evidence and that the witness knows, is competent to, is familiar enough with the report to testify about it. That's an assumption which is being challenged.

In the first place, assuming that he does know what the so-called Sandia Report says, assuming he does know it, where are you going to go from there?

You are going to have a very hard time getting that into evidence in this proceeding, I suspect. Counsel may object.

What are you going to do with this cross examination?

MR. CAMPBELL: I was hoping that the higher figure that came out of the Sandia Report and the computer of 9,050 might indicate some revision of WASH-1400 that Mr. Levine, if he does not know about it, might be interested in commenting upon; specifically for Byron, which I believe he did indicate was less of a risk than other nuclear reactors in the United States.

(Board conferring.)

JUDGE SMITH: Would you restate the question?

MR. CAMPBELL: The ball is in my court.

JUDGE SMITH: No. Mr. Reporter, would you restate the question.

(The question was thereupon read by the Reporter.)

JUDGE SMITH: Would you complete your question?

BY MR. CAMPBELL:

Q Would this figure be too high in your estimation?

MR. GALLO: Objection. It seems to me that it's just been disclosed by this exchange between the Board and Mr. Campbell that we have a pervasive confusion on this record.

As I understand it, the reference that Mr. Campbell is making when he refers to the Sandia Report -- and, perhaps, Mr. Thomas as well -- was the computer printout that was released by the Congressman.

Whereas, the witness, because of the reference to the Sandia Report, is answering the questions on the basis of the report itself as published by Sandia Laboratories.

So what we have are -- and we also have the witness' testimony that there is a variance between what the report said and what the printout says.

What we have here are questions related to the

printout under the guise of referring to the report and answers based on the report.

I submit that all of the questions in the area of the Sandia Report are suspect as to their reliability and I move that they be stricken, both the questions and the answers.

JUDGE SMITH: Well, it's just not that simple.

Now, last time the witness made it clear that he understood and I think the record is clear --

MR. GALLO: As to that one question, that is true, your Honor; but --

JUDGE SMITH: And I do think that we have been very sloppy in referring to the Sandia Report as a shortcut for the printout; and that is a distinction that has to be made.

There is another difficulty, and that is the Board itself is familiar with the printout. Congressman Marquis' release on it, and that the report is different, a different publication.

Now, I am sure you are referring to the printout, the worst-case printout, as I think it has been referred to, from the Sandia background data.

MR. CAMPBELL: Yes.

JUDGE SMITH: Now, make that clear in your question and let's see what the answer is.

MR. GALLO: Excuse me, your Honor. I have no problem with the Board's ruling and I don't mean to argue with it as just made; but I am concerned about the prior answers and questions. It was not until Mr. Levine clarified the answer not more than five minutes ago that I realized that Mr. Campbell and, perhaps, Mr. Thomas -- and perhaps an inquiry should be made of Mr. Thomas -- were asking questions under the label of the Sandia Report when they really meant the printout.

I don't know if Mr. Levine's answers would have been the same if he had understood that they were referring to the printout as opposed to the Sandia Report.

JUDGE SMITH: I understand now.

MR. GALLO: It's those prior questions that I object to.

JUDGE SMITH: Mr. Levine, what did you understand the questions -- if we can address the questions as a group, I don't know if that's possible.

What did you understand the questions to be?

THE WITNESS: I assumed they were talking about the printout.

JUDGE SMITH: What did you intend, Mr. Thomas, in your respective questions?

MR. THOMAS: Well, Judge, my questions really went to the report; but I am sure he understood.

I did not get into discussing numbers particularly with him. I asked him about how Sandia arrived at the conclusion that the most probably WASH-1400 melt-down categories resulted in the highest liquid pathway releases.

Now, I am sure that the witness realized that was from the report as opposed to the computer printout.

I didn't discuss the numbers that Mr. Campbell has gotten into.

JUDGE SMITH: I think it is clear from Mr. Campbell's questioning that he knew it was in the printout, that the witness knew it was from the printout and the Board assumed it was from the printout.

MR. THOMAS: Right.

JUDGE SMITH: I think the record is satisfactory on it; but I don't want to leave it until you are satisfied, Mr. Gallo, because you have a legitimate complaint here.

MR. GALLO: Well, I think the remedy is to review the transcript and to determine, in cooperation with the witness, exactly what he understood when the question was posed and see if there is a difference in the answer with respect to whether the reference was the report versus the printout and then come back to you with a request for a remedy should that occur.

JUDGE SMITH: I certainly think, in view of the carelessness that I myself have been guilty of in language, that that would be fair to the witness.

With no objection, we will proceed on that basis.

From here on in, let's have a precise understanding as to the document that we are referring to.

Also, you might bear in mind that we have our doubts that you are going to be able to get that printout into evidence unless you --

MR. CAMPBELL: Your Honor, I am not trying to get this into evidence.

All I am trying to do is find out the witness' familiarity and opinion on these questions.

JUDGE SMITH: Okay, all right. Now, with that, can you answer the question, assuming that you remember the question?

THE WITNESS: If I could have it repeated, I might give it a try.

JUDGE SMITH: Well, it's the -- it takes the comparable -- as I understand it, the comparable worst-case scenario from the printout and applies it to Sandia and you get something in the neighborhood of 9,000 early deaths -- to Byron.

With that, assuming that whatever you wish to assume from the question, does that change -- should that, in

your view, change the conclusions of WASH-1400?

Is that a correct restatement?

MR. CAMPBELL: That is, yes.

A I cannot answer that question with specificity.

I am aware of the methodology used by Sandia in generating that computer printout. I do not agree with it.

I can't comment about the validity of any one number at any one site, because it depends on what the calculation -- how the calculation went and where it rained and where the fatalities occurred.

I have already stated that I agree with the staff's representation of the predicted early fatalities as being -- and I am reading now from the Staff FES -- ten to the minus eight 1,140 people. I believe that's a conservative estimate; but I cannot comment specifically on the Byron calculation in that computer printout. I don't know enough about it.

BY MR. CAMPBELL:

Q In your opinion, does the fact that there will be more nuclear power plants than just one in an area increase the risk to the people living within that area?

A If you are talking about the specific areas in question in these contentions, I believe there is almost no coupling of early fatalities between the various sites. There may

be some coupling of latent cancer fatalities but it's very small. The number of latent cancer fatalities would be very small in any event with one reactor or ten reactors. The probability of early fatality -- of latent cancer fatality death would be very small whether there is one reactor or ten reactors in the area.

Q This --

A Considering the way they are located.

Q The latent death fatalities --

A Yes.

Q Is that due to accidental releases?

A Yes, that's what I am talking about.

Q Would there be an increase due to normal operations?

MR. RAWSON: Objection. Judge, this was an area that was disposed of or summary disposition; the question of health effects related to the health was fully litigated and the Board dismissed Contention 2-A, which was the question, in cumulative terms.

MR. CAMPBELL: That is true, Judge. I forgot. I am sorry.

JUDGE SMITH: Okay.

MR. CAMPBELL: I continually forget that we cannot talk about that anymore. I am sorry.

JUDGE SMITH: Proceed.

Your question is withdrawn?

MR. CAMPBELL: Yes.

BY MR. CAMPBELL:

Q The chances of an accident then you think do not increase because of the number of nuclear power plants, with the number of nuclear power plants?

A Yes, they do.

Q They do?

A Yes, the chances of an accident.

Q Is this generally recognized --

A Well --

Q -- or is this your own opinion?

A -- if you have one reactor -- and let's assume you have ten identical reactors -- if you have one reactor which has a certain accident frequency, if you have two of them or three of them, the frequency goes up if they are all the same.

Q Now, you haven't looked at the reactors that Commonwealth Edison is now operating within Northern Illinois?

A I don't know what you mean by I have looked at them.

Q Have you looked at them? Have you determined the accident probability of each reactor?

A No.

Q Has anyone done this?

A Not that I am aware of. Maybe some of them have been determined but certainly not all of them.

Q In NUREG CR-2497, Volume 1, Precursors to Potential Severe Core Damage Accidents, 1969 to 1979, a status report, gives an indication that the probability of a severe core damage accident similar to Three Mile Island happening between between '69 and '79 was between 1.7 times ten to the negative third and 4 times five minus ten to the negative three per reactor year.

Would you consider this high or low?

A Probably high.

Q A high estimate?

A I have already testified that that was based on data I think even before TMI happened.

I have already testified that I think since TMI happened there have been actions taken by NRC and the industry to make the probabilities of such accidents even lower.

Q What is your general opinion of the precursor study?

A I think it's a flawed methodology.

Q Why does --

A As covered in my testimony. I will be glad to repeat it.

Q If -- generally, if you could, specifically for the public. --

A I think the methodology used is bound to give you estimates that are too high, because they take a rare event that happened at one reactor and not any other

reactor and they then have a frequency of one over 432, which was the number of reactor years in the data set, and they then create some kind of generic event tree, I am not sure which reactor it's applicable to, and then fill in the rest of the event tree by data from various sources, such as other PRA's or LER data, and they get a number.

I think that number is virtually meaningless.

I think to understand what that precursor event means you have to take that precursor event, have an event tree specifically for the reactor at which it occurred and make an analysis of that event tree for that reactor and then you would have a number that was meaningful.

INPO, Institute for Nuclear Power Power Operations, did just that and got numbers very much smaller than the precursor study; and that's a proper methodology that should be used in this event in these kinds of analyses.

Q Are you --

JUDGE SMITH: I think it would be better if we could finish your cross examination before lunch, unless that is --

MR. CAMPBELL: He has brought up the INPO study. I would suggest that we probably break for lunch now.

JUDGE SMITH: I would like to discuss again now how we arrived at this point. First I go back to the stipulation, and what the stipulation does is not quite as

strong as that which the Board might have ordered. The stipulation says that the parties agree with respect to those consolidated contentions, including the issue that we are litigating now, the non-lead Intervenor shall have the right to non-duplicative presentation of evidence, other than direct testimony, and the right to examination and cross examination, briefs, proposed findings of fact, conclusions of law.

Now, our oral admonition was a henceforth that even with respect to non-duplicative presentation, non-duplicative cross examination, the non-lead Intervenor shall attempt to work his cross examination in with the lead Intervenor, which goes beyond your stipulation; but your representation to the Board was, when I asked you for a cross examination plan, that, no, you could not have a cross examination plan, because all of this is follow-on from Mr. Thomas' cross examination.

That, really, is becoming more apparent that I didn't understand what you were saying or something is amiss here. Something is amiss because you have a very substantial, non-duplicative testimony on cross examination here, which I don't know what your cooperation with Mr. Thomas was, but I think at the very least you have probably prepared cross examination in advance. You didn't prepare that while Mr. Thomas was cross examining.

MR. CAMPBELL: Your Honor, I have -- I prepared testimony --

JUDGE SMITH: Cross examination?

MR. CAMPBELL: -- cross examination only insofar as I was sitting here writing down questions that I felt that Mr. Thomas did not follow-up on.

JUDGE SMITH: You had no cooperation of Mr. Thomas before this morning?

MR. CAMPBELL: Oh, yes. We talked. We talked about such things; but, again, it was with, you know, working out what questions to ask; and then Mr. Levine has been giving such good testimony that I have just been naturally asking the questions that come up after each time he brings in a new point.

JUDGE SMITH: The effect of which is that it's entirely different testimony which has not been consolidated, has not been worked out in cooperation with the Intervenors.

MR. CAMPBELL: It is testimony or it is cross examination questions based upon what Mr. Levine said today.

JUDGE SMITH: Well, let's, as we continue after lunch, bear in mind -- did you have something else to state?

MR. CAMPBELL: I can give you an idea over lunch

as to what some of the -- you know, a short outline, again, of where I would be going now with what Mr. Levine brought up on certain points.

If you could wish, I can attempt to have something typed up and presented to you and Xeroxed off.

JUDGE SMITH: That is not necessary. Maybe we will just have a -- unless you don't want the other parties to know, we will just have more representation from you.

MR. CAMPBELL: Thank you.

JUDGE SMITH: All right. We will return then at 1:30. This is a little bit longer than usual.

(Whereupon at 12:10 P. M., the hearing in the above-entitled matter was recessed, to reconvene at 1:30 P. M. of the same day.)

AFTERNOON SESSION

(1:30 P. M.)

JUDGE SMITH: You may proceed, Mr. Campbell.

MR. CAMPBELL: I believe we left off at the INPO Study.

JUDGE SMITH: No. Where we left off is you were going to either give me an oral representation of where you are going and what your plan is or a written indication, if you want to keep it confidential.

MR. CAMPBELL: The oral presentation is just that I would like to question Mr. Levine on the INPO Study and find out how the study arrived at certain conclusions relating to your ORNL Study or otherwise known as the precursor study.

Then I would like to ask his opinion on certain things within the ORNL Study and with some site specificity to Byron.

JUDGE COLE: You said ORNL Study.

You are referring to the precursor study?

MR. CAMPBELL: Yes.

JUDGE COLE: O-R-N-L?

MR. CAMPBELL: Yes.

Perhaps I should call it, then, the precursor study.

JUDGE COLE: All right, sir.

I want to make sure we are referring to the same study.

MR. CAMPBELL: Unless there are things that would come up by redirect or if the NRC brings up anything, that would be the end of my cross examination.

JUDGE SMITH: All right. Proceed.

BY MR. CAMPBELL:

Q Could you, Mr. Levine, tell us about just where the INPO Study came from?

A I don't know what you mean by "came from."

Q Did it come from Harvard University or --

A It came from the Institute of Nuclear Power Operations, which is the acronym for -- which is INPO.

Q Is that a government body?

A No. It's an industry body.

Q How many events did the INPO Study evaluate?

A I don't know.

I know only the methodology they used, and it's the methodology I would have used if I were doing a precursor study.

As I said before, I would take the event -- this rare event -- that occurred at one reactor, and I would model its impact on that reactor using event trees applicable to that reactor and other data applicable to that reactor in terms of estimating the impact on

core-melt frequency or degraded core frequency.

That's what INPO did; and I think that methodology is far superior to the methodology used in the precursor report, and the methodology in the precursor report, in my opinion, is flawed.

Q In your opinion, was it a thorough analysis of the precursor study? Did it --

A The INPO Study?

Q Yes.

A I haven't studied it in enough detail to answer that question, but I am sure it was.

I examined both of these studies from the question of methodology, what methodology was used in the precursor report and what methodology was used in the INPO report, and the two methodologies are very different.

One is flawed and one is sort of just right.

Q Are you familiar that the Advisory Committee on Reactor Safeguards Subcommittee on Reliability and Probabilistic Risk Assessments, in their March 9th meeting, discussed the INPO Study, and that they reached a conclusion that -- almost contradictory to what you --

A No, I am not aware.

MR. RAWSON: Objection, Judge, objection.

It seems to me that question is objectionable on several points.

MR. CAMPBELL: I withdraw the part about how it was characterized.

JUDGE SMITH: Well, restate your whole question.

BY MR. CAMPBELL:

Q Are you familiar with the Advisory Committee on Reactor Safeguards Subcommittee on Reliability and Probabilistic Risk Assessment meeting on March 9th that reviewed the INPO --

A No; but I would have been there if I were not here.

March 9th was Monday, I believe -- no, it was Friday, it was Friday.

I would have been there except that I had to come here.

Q Do you think that the INPO Study was slightly over-optimistic about the --

A I think they used an appropriate methodology; and I am sure the methodology used in the precursor report was flawed and should have given answers that were -- probabilities that were too high compared to reality.

Q This methodology, could you explain that?

A I have already.

I will explain it again.

Q Please.

A They took a rare event that happened at a single reactor, which had a probability of 1 in 432 per reactor year, and

they then took a generic event tree, which they weren't sure was applicable to that reactor, and they then quantified that -- an accident sequence in that event tree, using this precursor data and some data from various sources, such as other PRA's or LER's, and they got a number.

That number is not particularly applicable to anything. It's not the way to do a study like that. It's bound to give you answers that are too high.

Q Didn't the ORNL or the precursor study study the actual number of accidents that occurred between 1969 and 1979?

A That's what gave them the number of 1 in 432; but those events happened -- each event happened at one reactor and they did not analyze its impact on that reactor. They analyzed it on some nonexistent reactor, some generic reactor.

Q They studied the number -- they studied the number of accidents that had occurred in all different reactors?

A Yes; but they found precursor events that had been, each one, only at one reactor, and they analyzed each one of those in some kind of generic event tree.

Q And your suggestion is that the INPO Study had a better methodology?

A Absolutely.

Q What methodology did the INPO Study use to evaluate the --

A For the third time, for the third time, I will tell you.

They took the rare event that was applicable to the reactor on which it happened and they used an event tree applicable to that reactor and they used other data applicable to that reactor to quantify the accident sequence.

That gives you an answer that is more likely to be real than -- much more real than -- the answer in the precursor report.

Q Did they use the same methodology for studying the Brown's Ferry accident?

A I don't know.

Q Do you know what methodology they used for evaluating --

A I can't talk about any one specific precursor analysis.

I am just talking about the general methodologies used in the two studies.

Q How much time did the evaluation of the INPO Study take?

A I don't know.

MR. GALLO: Objection.

Whose evaluation?

BY MR. CAMPBELL:

Q Of the INPO -- or the INPO evaluation take?

MR. GALLO: Still the same objection.

The question has no meaning.

JUDGE SMITH: Mr. Gallo, I am sorry. I didn't

hear your first objection.

MR. GALLO: The objection is based -- your Honor, as I recall the question, the question was how long did the INPO evaluation take.

The objection is that the question is vague and not subject to being given a meaningful answer.

JUDGE SMITH: I don't know what you are going to do with the answer.

MR. CAMPBELL: He said he didn't know, so I --

BY MR. CAMPBELL:

Q Do you know how much time the INPO Study spent reviewing each of the events of the precursors?

MR. GALLO: Objection; immaterial.

We have had lengthy testimony from this witness that the only relevance that he attached to the INPO Study versus the precursor study was the overall methodology used in each study; that the individual events were not important to him.

Therefore, questions about how much time was spent in analyzing each event are immaterial to the issues here and wasting time.

JUDGE SMITH: Would you care to respond to that?

MR. CAMPBELL: There are criticisms of the INPO Study and I was -- and of the methodology, and I was attempting to find out whether he was familiar with those

criticisms and what his opinion of those criticisms were.

JUDGE SMITH: Okay. But how many times are you going to run up against this answer, the only thing he familiarized himself with was the methodology?

Let's find out. You may answer, if you know the answer.

A I don't know.

BY MR. CAMPBELL:

Q With the ORNL or the precursor study, 14 of the precursors used in the ORNL Report were events experienced at Commonwealth plants -- Commonwealth Edison plants -- from 1970 to 1979.

Would this indicate that the cumulative effect of the risk would be greater because of some of these potential precursors happening at Commonwealth Edison plants?

A The question is --

MR. GALLO: Objection. The question is based on facts and premises not in evidence; namely, how many precursors happened to Commonwealth plants.

JUDGE SMITH: That seems to me to be a valid objection.

Do you want to comment on it?

MR. CAMPBELL: I would have to submit either the ORNL Study in as testimony or -- I mean, as evidence or --

JUDGE SMITH: Well, maybe the witness knows how many Commonwealth Edison precursor events were analyzed.

I suggest, however, that -- well, let's find out if he knows that.

Do you know?

A (Continuing.) I don't know the answer, and I think the question is not pertinent to what we have been talking about, because he hasn't identified -- there are a lot of Commonwealth Edison plants, and he hasn't identified whether they happened all at one plant or evenly distributed among the plants or were they different types of events or the same types of events.

JUDGE SMITH: Well, inasmuch as you don't know the answer, the rest is not really important, is it?

BY MR. CAMPBELL:

Q But the fact that there are potential -- or that potential precursors have occurred at the Commonwealth Edison's plant is important and it does bear upon -- is it not? -- and it bears upon the probability of an accident occurring at Commonwealth Edison's --

A What you and I know together in this courtroom may or may not be important. Probably not important would be my judgment, but I don't know.

Q If an accident occurs at --

A These were not accidents. These were precursor events.

Q Precursor events?
A Yes.
Q If a precursor event occurs continually at a plant, would that increase the likelihood of another event occurring that could lead to severe core accident?
A It's possible.
Q So, Mr. Levine, you are not familiar with any of the other plants -- or any of the other precursor -- potential precursor accidents at any other of the Commonwealth Edison's plants?
A That's correct.
Q In reading our contention, did you not question the chances of so many -- of an accident occurring at Commonwealth Edison's plants?
A (No response.)
Q In reading our contention --

JUDGE SMITH: That is DAARE/SAFE Contention 2 a?

MR. CAMPBELL: 2 a, yes.

BY MR. CAMPBELL:

Q The chances of an accident happening at one --
A I used my knowledge of what various PRA's have found about the likelihood of accidents that could cause large releases; and I think that these PRA estimates are more competent than any estimates in the precursor report.

The precursor report talked, in the first place,

about estimates with degraded core probabilities, not core probabilities that would release large amounts of radioactivity to the environment.

The two subjects are quite different from one another.

Q How are they different?

A Because a degraded core does not challenge the integrity of the containment or many of the engineering safety features in the plant; and, therefore, there is not likely to be a large release of radioactivity, as in Three Mile Island, where there was almost no release of radioactivity from a degraded core.

Q You give a probability of an accident happening at Byron or at any one of Commonwealth Edison's plants as being very small, very small risk.

Would the fact that -- again, you can take this hypothetically.

Would the fact that there is poor quality assurance/quality control at the plant increase or decrease the probability of an accident at Byron?

MR. GALLO: Objection.

Is this a hypothetical question or is this a premise that -- a factual premise that is attempting to be established?

If it's the latter, I object to the question.

MR. CAMPBELL: Hypothetical, hypothetical.

MR. GALLO: Withdraw the objection.

Does the witness need the question back?

THE WITNESS: No, I have the question.

A It's a very complicated answer to that question.

In WASH-1400 we analyzed the two reactors, whose designs are now 20 years old or more, the Surry reactor and the Peach Bottom reactor. Those plants were not built to current standards.

The data we use in the PRA's comes from many sources, conventional types of plants with pumps, pipes and valves, and those components are not built to current nuclear QA standards.

Even with those data, we find the risks from reactor accidents are many small.

I think that modern plants, which are built to better QA standards, will have even lower risks.

MR. CAMPBELL: Now, I --

JUDGE SMITH: I think it might be helpful, Mr. Levine, if you answer the question in the form in which the question is presented and then go on with your explanation.

I think he was entitled to a yes answer to that one.

THE WITNESS: Well, I don't think so.

JUDGE SMITH: Well, if better quality assurance

reduces the probability of accidents, does it not necessarily follow then that worse quality assurance increases the probability of accidents?

THE WITNESS: But the real question is: What is the quality assurance at the Byron plant compared to the quality assurance in the WASH-1400 plants.

JUDGE SMITH: It's a relative question, it's a relative question.

THE WITNESS: And I think it's better than in the WASH-1400 plants because of the lapse of time and the changing requirements.

JUDGE SMITH: All right.

THE WITNESS: I would rather answer the question in that order, if you don't mind.

JUDGE SMITH: You will answer the question in a form you are directed to answer it.

He is entitled to answers to his questions.

MR. GALLO: Mr. Chairman, I object to bullying of the witness.

JUDGE SMITH: I am not bullying the witness.

MR. GALLO: It sounds to me like you just were.

JUDGE SMITH: Be seated, counselor.

MR. GALLO: May I be heard?

JUDGE SMITH: Yes, you may.

MR. GALLO: All right. It seems to me, Mr.

Chairman, that the witness was attempting to explain the basis for his answer; and with all due respect, I believe it was improper for you to use your tone of voice and admonish the witness in the terms that you did. I consider that to be bullying the witness.

JUDGE SMITH: The transcript will reflect what has happened.

Now, let's have the question read back.

(The question was thereupon read by the Reporter.)

JUDGE SMITH: Now, it is my view that that question can be answered yes or no.

If you don't believe it can be, with explanation, that's fine; but I would bring to your attention that he is entitled to a yes or no answer.

A I am very sorry, Judge.

My answer would have to be that there is an explanation required to put that question in perspective --

JUDGE SMITH: Yes, right.

A (Continuing.) -- and the answer --

JUDGE SMITH: I want you to make your explanation.

A (Continuing.) -- the answer is that it might or might not be.

Now, what are we talking about here?

We are talking about, in fact, estimates of accidents, accident probabilities and consequences, that are based largely on WASH-1400 methodology, some variation in the results of WASH-1400 employed by the Staff, the NRC Staff, in drawing up the FES estimates for the -- the FES estimates for reactor probabilities and consequences and --

JUDGE SMITH: Mr. Levine, I really don't want to interfere with your testimony.

All I want is for the answer to be as responsive as it could be; and let me back up.

I thought that when you were able to state that improved quality assurance diminishes the risk of probabilities of an accident, that a logical follow up with that, that worse quality assurance increases it.

I just felt that you should have been able to answer it with a yes or no with an explanation.

I am not trying to develop the record. I am just trying to get responsive answers.

I don't intend to address this further. I will take your answer as it is on the transcript.

BY MR. CAMPBELL:

Q Again, hypothetically --

JUDGE SMITH: Did you perceive me bullying you?

THE WITNESS: No, sir. I just feel that we have an intellectual disagreement, which can happen, your

Honor.

JUDGE SMITH: I think that I -- and I will take the blame for it. For some reason I am not explaining my concern, my inference, drawn from your testimony adequately.

I know that you have tried to answer questions fully here.

THE WITNESS: I am trying to be as fully responsive as I know how to be, Judge.

JUDGE SMITH: Proceed.

BY MR. CAMPBELL:

Q Mr. Levine, do you know of or are you familiar with any proposed modifications which may be made to the Byron steam generators or the feedwater system which could affect its Class 9 accident probabilistics or potential?

A No, I am not aware of any.

Q Would the fact of a poor evacuation plan at Byron hypothetically affect the probabilistic chances of people dying in an accident?

A By a very small amount. From a reasonable evacuation, such as we estimate, and as I have described before, in the CRAC and CRAC 2 models, to no evacuation, is only a factor of two prediction in early fatalities; and that factor of two is very small compared to the uncertainty in such predictions.

Q Am I to understand that, because of the evacuation plan truly not being effective and the chances of evacuating people out of the area, the effects are very similar whether you evacuate people or not?

MR. GALLO: Objection. The question assumes premises not in evidence.

He made the statement that evacuation plans are known not to be effective.

JUDGE SMITH: Sustained.

MR. CAMPBELL: Are known not to be effective, did you say, Mr. Gallo?

BY MR. CAMPBELL:

Q Then to understand your statement, the evacuation plan does not lend -- is it true that the evacuation plan does not lend itself to protecting the people?

A No; it does and it's useful to have, but the effect is not large.

Q The effect of not evacuating people is not large?

A That's correct.

This is stated in WASH-1400, it's stated in NUREG 0715.

Q Could you tell me why that is so?

A Because the evacuations are not very efficient, but they are worth doing.

Q Does the area to be evacuated increase or change the

problems -- let me strike that.

Does the fact that the amount of people that might be around the nuclear power plant, such as Byron, make it more difficult to evacuate, such as in Byron there would be more tourists down there than, let's say, at Zion, in which you have fixed houses and people living there continually?

A There is a --

MR. GALLO: Objection. The question is relevant to the ability to evacuate the Zion site or the Byron site. It is immaterial and irrelevant to Contention 2 a that deals with cumulative effects.

In addition, the question is cumulative, in that it's repetitious of the Chicago evacuation questions asked by Mr. Thomas.

MR. CAMPBELL: I will withdraw that.

I don't have any further questions.

Thank you.

MR. RAWSON: Mr. Levine, my name is Richard Rawson.

I have just a couple of items for clarification.

CROSS-EXAMINATION ON BEHALF OF
THE NUCLEAR REGULATORY COMMISSION

BY MR. RAWSON:

Q Do you have your prefiled testimony before you, sir?

A Yes, I do.
Q Can you refer to Pages 19 and 20. I would like to ask you to focus your attention on the discussion of the emergency core cooling system.
A Yes.
Q Mr. Thomas asked you a question earlier about whether Byron is unique with respect to its having the ECCS, as described in your testimony.

Do you recall that question?

A Yes, I do.
Q I believe your answer to that question was that essentially all plants have that ECCS.

Do you recall that testimony?

A Similar ECCS's. That is with redundancy and the like.
Q I wanted to understand better what you mean by the term "essentially all plants."

Was it your intention to include all operating plants within that class of essentially all plants which you testified have similar ECCS systems?

A Essentially all large PWR plants.
Q Was it your intention to include within that term, for example, older operating plants, plants which were licensed --
A No. That's why I used the term "large." I mean in the neighborhood of 1,000 megawatts.

There may be some older plants that have different kinds of systems.

Q Thank you.

A few moments ago, in response to a question from Mr. Campbell, you testified, I believe, that degraded core does not challenge safety systems.

A I said does not challenge the containment and in general its safety systems, the containment's safety systems; and by "challenge," I mean their ability to operate and perform effectively.

Q I am still having trouble understanding what you mean by "challenge."

Can you put that in context for me, please?

A Yes. A molten core, for example, creates conditions in the containment that can lead to challenges to containment integrity and to fan coolers, perhaps, high pressures, high temperatures, hydrogen burning and the like.

A degraded core is not likely to do that. It's not likely to challenge the integrity of the containment, less likely to -- it's less likely to challenge the integrity of the containment.

While it might generate some hydrogen, you are not going to start from a -- you are going to start from a low ambient pressure in the containment, so a hydrogen burn is of less concern and the like.

MR. RAWSON: Very good. Thank you, sir. That's all I have, Judge Smith. Thank you.

JUDGE COLE: Just a couple of questions, Mr. Levine.

BOARD EXAMINATION

BY JUDGE COLE:

Q With respect to the Lewis Committee Report, which, it has been said, criticized the executive summary of WASH-1400 studies -- I think that is fair to say that, isn't it, sir?

A Yes, it is.

Q Now, with respect to the nature of the criticism and its manifestation -- and its implications, is it fair to say that the major criticism of the Lewis Committee had to do with other than the estimates that were made in the WASH-1400 study, but had more to do with the error bands around the estimates?

Is that a fair general statement of the major criticism of the Lewis Committee of the WASH-1400 study?

A I think that is fair, except they did say, also, they were unable to determine whether our central estimates, or the best estimates, if you will, were too high or too low; but I think that statement depended on the fact that the error bands were larger than we had reported.

Q All right, sir.

With respect to the Three Mile Island accident, sir, could that -- is that or could that be described as a core-melt accident?

A I would not so describe it, although there may have been some small parts of the fuel that were molten at one time, I don't really know; but in the parlance of PRA's, when we talk about molten, a molten core, we talk about essentially the entire core melting, the whole 100 tons of fuel or nearly the whole 100 tons of fuel, and that surely did not happen at TMI.

Q Do you know if there is any evidence of any melted fuel in the TMI accident?

A There is speculation that there may have been some central melting of fuel rods.

I think the final answer will wait until we get some -- some fuel is taken out of the reactor and examined metallurgically. Then they will be able to determine if melting really occurred or not or how much occurred.

If I may expand on that answer?

Q Let me -- yes, please do, sir.

A I would just like to differentiate it.

Once again, between -- a small amount of melting is not very significant. If you melt a few fuel rods or a bundle, it's not very significant compared to melting most of the core. They are very different kinds of events.

The molten core, for instance, will melt through the bottom of the reactor vessel. A melted bundle doesn't go anywhere. It just stops.

Q All right, sir.

Did you observe any of the films taken of the degraded TMI core?

A I saw one film that lasted about 15 minutes.

Q All right, sir.

When you talk about a degraded core, is this different from a melted core, in your view? What difference do you make between those two terms?

A Yes, different; very different.

A degraded core could loosely be described as a core whose geometry has changed significantly, to the point that you can't cool it very well, say, at power, or the -- some of the fuel rods were essentially pulverized and no longer --

Q By "pulverized," you mean, sir, that the cladding has been destroyed?

A The cladding has been destroyed and the fuel pellets may have broken up into small pieces; and that's clearly what happened at Three Mile Island.

Q All right, sir.

So the cladding could be destroyed and the pellets could be in pieces without having a melt, a fuel melting;

is that correct, sir?

A That is possible; yes, that is correct.

Q All right, sir.

Now, I want to get back to something that you answered a large number of questions about, methodology and the precursor study and the INPO Study and WASH-1400.

A Yes.

Q Sir, on Page 25 of your testimony, referring to the precursor report, which was prepared under contract by Oak Ridge National Laboratory for the Nuclear Regulatory Commission, in the top portion of Page 25 you say, "The important point, however, is that the precursor report used generic numbers that were fed into generic event trees."

Later on you indicate that that is a serious flaw in their study, and you made that point several times.

I guess I want to make sure I understand what the words mean.

Now, the word "generic" means to me having general application, the term generic itself; and if you use numbers that have general application and you feed those numbers into event trees that have general application, I guess I am confused, sir, as to why that wouldn't have general application.

A I guess these are terms that, I believe, the precursor

report used; and my view is that they are not applicable to this kind of analysis.

As I said earlier, from the information I have, all the precursor events defined were unique; that is, there were no -- there weren't 10 of the same kind of precursor event. There was a precursor event of a type that occurred at one reactor, and that's what gave the frequency of 1 in 432, because that was the number of years -- reactor years -- in the data base.

So with the thing that happened at one reactor, it seems to me you should not take an event tree that is not applicable to that reactor and try to quantify the meaning of that precursor event.

You should take that event that happened in that reactor and use an event tree applicable to that reactor and other data applicable to that reactor to fill out the quantification of the accident sequence.

Otherwise, you have something you are not sure what the applicability is.

Q All right, sir.

So you are telling me they did not use generic event trees?

A I don't think there is such a thing as a generic event tree that is fully applicable to all reactors. In fact, I know there isn't.

Q All right, sir.

So if it was truly a generic number and truly a generic event tree, would it apply?

A Yes, you are right, it would apply; but it's not.

Q So you are saying that, then, they used ungeneric numbers and ungeneric event trees and you just can't apply it?

A That is correct, that is roughly correct, yes.

Q All right, sir.

A I am sorry for the misterminology.

Q I just wanted to make sure I understood. I heard your answer and I understood it, but I couldn't understand the words.

A Yes.

Q Now, with respect to the methodology that was used in WASH-1400 --

A Yes.

Q -- the incidence that they derived and the event trees that they used, how was that methodology different than the precursor study and, if it was, as you indicated before, specific to only one plant, how can we then apply it to other places?

A That is a very good question.

Q That is too many questions.

A No. I understand the train of thought and I think I can keep it in mind in answering it.

Q Thank you.

A The event trees in the WASH-1400 were specifically for the two reactors analyzed in WASH-1400, so they were specific to the event. The events trees for Surry were specific to Surry. The events trees for Peach Bottom were specific to Peach Bottom.

To quantify the sequences that come from the event tree, you have to define the initiating event which the event tree starts with -- for instance, a pipe break or a turbine trip -- and there we use data, generic data, from many sources to get a pipe failure probability for large LOCI of ten to the minus four per reactor year.

We, obviously, did not have data on large LOCA's in reactors because none had happened, so we took large -- we took data from large pipe breaks from all kinds of plants to get that number. We used that number, not directly applicable, but that's the number we used.

Then in quantifying the accident sequences in the event tree, which then consisted of system failure probabilities, we drew fault trees for the systems in each plant, specific fault trees for specific systems, and then we inserted failure rate data into those fault trees that came, again, from many sources. We had failures of valves, failures of pumps, failures of circuit breakers and the like.

Much of that data was non-nuclear data. There was a small amount of nuclear data. When we did WASH-1400, most of it was non-nuclear data, but we used that data in those trees and that's how we quantified our accident sequence probabilities.

Q All right, sir.

A Have I answered the question?

Q Yes.

You have indicated to me that it's highly specific to that plant?

A Yes, with some reservations about data being not directly from that plant but from similar kinds of components.

Q All right, sir.

So how -- could you then make it clear to me what the difference is between what the precursor study did and what you did in WASH-1400?

A The precursor study used data from LER's that was more than a single event in an accident sequence.

Imagine an accident sequence that has four events in the chain. They would find an LER that covered two of those events and use that frequency for those two events and they would then try to characterize the probability of the other two events to complete the sequence probability.

The first thing they should have done was used an event tree that was specific to the reactor in which that

rare event occurred, because that event had not occurred in any other reactor, it occurred in that reactor, and it's not clear what its number would be for another reactor. It's not clear how much it might have changed.

Then they did not quantify the remaining steps in the sequence for that specific reactor. They took data from various sources, which might or might not be applicable to that specific reactor.

Furthermore, when you quantify an accident sequence in a specific analysis for a specific reactor, you iterate the quantification a number of times to be sure you have got the right numbers in the right places to get a realistic assessment.

In the kind of methodology they used, you cannot iterate because you can't look at the applicability of the models you have in the accident sequence to your specific reactor and make sure they are applicable. There is just no way to do that.

Q All right, sir.

The INPO Study was -- the purpose of the INPO Study was to respond to the precursor study, was it not, sir?

A That is correct.

Q So it started some time after the publishing of the precursor study, which was in June, 1982?

A I assume so; but I know that INPO was doing studies of

that type before the precursor report was issued.

They were planning to look at such events themselves, so they may have done a little work beforehand. I am not sure.

Q They were inspired to greater effort by the precursor study?

A I would expect so, yes.

(Laughter.)

Q Now, with respect to the methodology that was used in the INPO Study, how does that contrast with the methodology used in the WASH-1400 study and/or the methodology used in -- and the methodology used in the precursor study?

A It's more akin to the WASH-1400 study, in that they found the precursor event, which was applicable to reactor, let me call it, No. 32.

Q All right, sir.

A They then drew event trees applicable to that reactor and they then modeled the remaining two events in the accident sequence -- and this is hypothetical example -- with models and data specific to that plant; and that's what we did in WASH-1400, except we didn't have any precursor events. We just modeled them all.

Q All right, sir. Thank you.

On the first full paragraph on Page 25 of your testimony, sir, you indicate that the INPO report found

that the actual detailed plant configurations, when they are taken into account, it generally lowers core damage probabilities by a factor of somewhere between one-tenth to one-thousandth.

A Yes. I think there was one accident sequence, sir, where the accident probability went higher than that in the precursor report; but this is generally true.

Q All right, sir.

How does Byron fit into this? Is there anything specific about that that we can say about increasing, decreasing, core damage probabilities as regards Byron? Where does it fit in in this range; do you know, sir?

A I would say I can't answer. I don't know how to answer that question.

There certainly has not been a precursor applicable to Byron, because it's not operating yet. So it's very hard to answer.

JUDGE COLE: All right, sir. I understand that. Thank you.

JUDGE CALLIHAN: Just a couple of questions, Mr. Levine.

BOARD EXAMINATION

BY JUDGE CALLIHAN:

Q There was an exchange of some duration earlier in your appearance between you and Intervenor's counsel concerning

information out of the Sandia National Laboratory.

It, I think, finally came to pass that some of the reference, at any rate, had been to so-called computer printout.

Did you not imply at that time that there has now appeared a more formal report of that work done at Sandia?

A Oh, yes, there is a Sandia Report that does not have in it some of the information that's in the computer printout.

Q It does report on the same problem?

A It's a report on the same work.

Q On the same work?

A Yes.

Q Had the question about Byron, which, as I understood the question at that time -- had that question been addressed to the report rather than, as I recall, to the printout -- may I interrupt myself to say -- to ask if you agree with my remarks thus far?

A Yes, I understand.

Q Had the question been addressed to the report rather than the computer printout, what answer would you have given concerning the Byron reference?

A It's very hard for me to differentiate one plant from another in that report.

You look at the curves, that are the printouts of all of those sites, it's sort of like a black mass and

it's very hard to pick out one plant from another.

While it may be spelled out in other places in the report, I did not look for that level of detail.

Q Thank you.

One final, very general approach.

We have in hand today the results of certain research and analyses to which there has been considerable reference in this session.

Where, in your opinion, do we go next or, more specifically, what additional information or experience or whatnot does one need to be more -- to allow a more quantitative prediction of accidents and their effects?

A If I could change one word in your question to say from more quantitative to less uncertain predictions.

Q All right. I accept that. Thank you.

A There are a number of areas that are of great interest.

One, we have to have better models of human factors, the likelihood of humans making errors.

There has been already a significant improvement in that modeling, and we hope for more improvements in the future.

We have to know more about molten core interactions with other kinds of things, the hydrogen generation rates, hydrogen distribution, although we are learning more about that than we ever did before.

We have to understand principally, I think, how fission products will behave in these very severe accidents.

It's my view that the estimates we made in WASH-1400, which were the best we could do at that time, are probably too large by some factor. I am not sure what the factor is, but they are probably too large by some factor.

If they were too large by a factor of ten -- that is, the largest releases estimated in WASH-1400 were too large by a factor of ten -- then we would predict no early fatalities from the worst accident in a reactor and we would predict very much smaller number of latent cancer fatalities.

If that were to happen, everybody's view of reactor safety would change significantly.

People are working very hard now, both at experiments and models, to try to estimate those source terms more realistically.

There is some very recent work by Battelle-Columbus, performed for NRC, which has indicated in many of the sequences the numbers drop significantly, but there are a few sequences where they have not dropped significantly, where they are still quite large.

However, that research did not describe the accident

sequences more realistically than in WASH-1400.

They did not, for instance, re-examine the time at which the containment would fail; and I have already mentioned how important that is, that, if the containment were to fail in 12 hours as opposed to 1 hour, you would have a vastly smaller source -- a significantly smaller source term. That hasn't been done yet. It's going to be done.

It's my hope in the next year or two you will be able to estimate the source term -- estimate source terms that are somewhat smaller than they are now.

If it's a factor of ten, it would be very nice. If it's smaller, it would be very useful.

That would reduce a lot of the uncertainty in the current predictions that we make.

There are some other areas that are important, too. I haven't covered all of the elements.

Q Did information come out of Three Mile Island that might affect the results and interpretation of WASH-1400 and particularly, as an example, I cite the iodine, cesium finding; and can you comment on that, please?

A Yes. It's not clear. Certainly, a lot of cesium and iodine came out of the fuel in Three Mile Island, and very little got out of the reactor, but the pathway from the fuel to the containment atmosphere was through water; and,

of course, in any reactor accident, if the fission products bubble through water that is cold, cesium and iodide will be largely absorbed, so the cesium and iodine ended up in the water.

Now, there are accident sequences that are postulated in reactors where it's not clear that the fission products will go through water.

Example. If the core melts and the sprays are not running and the fan coolers are not running and the containment overpressures and the containment fails very quickly, you will get a very large release of radioactivity. If the sprays and fan cools are running, you will get a very small release of radioactivity. So water is very important in the reduction of fission product releases.

At TMI we have a measurement of how important it is, although we always knew it was important.

There is still research going on at TMI to try to use the data that is coming from TMI to evaluate various codes that predict fission product behavior, and that will be helpful.

Q Has any significant finding come out of the work at the Idaho site, which is referred to as the LOFT Program?

You have got to help me for the record. Loss of Fluid --

A Test.

Q Test. Thank you.

-- that might affect the predictions of WASH-1400?

A I think the major impact so far is that when we started WASH-1400, there was some question about the efficacy of ECCS in cooling the core. That question has gone away completely now with the LOFT tests.

We know there is a large margin and thermohydraulic capability of ECCS systems.

There has been very little work done on fission products. In fact, there has been no work done on fission product behavior in LOFT, but LOFT is now being sponsored by a consortium of OEV countries in a three-year program, and I am consulting to DOE in this area, and we are currently planning fission product experiments, two fission product experiments to be conducted in LOFT, hopefully to get further validation of fission product behavior codes. So more work will be coming from it.

JUDGE CALLIHAN: That is all I have; and thank you very much.

JUDGE COLE: Just one question, Mr. Levine.

BOARD EXAMINATION

BY JUDGE COLE:

Q Some place in your testimony or on the witness stand you mentioned molten core concrete interactions and some

recent research developments in that area.

A Yes.

Q Now, obviously, in WASH-1400 certain assumptions were made about time for the molten core to pass through the concrete, and the numbers that come out are as a result of the assumptions that were made in WASH-1400.

What does the recent research tell us with respect to the time estimates that might have been used or that were used in WASH-1400 and what are the implications with respect to the numbers?

A In WASH-1400 we estimated, by an incorrect model, because we had no data, it might take a half-a-day to a day for the molten fuel to melt through 12 feet of concrete, which is the base mat thickness.

Today, based on research done at Sandia, we have a model that explains how the molten fuel and concrete interact, and give us a rate of attack as a function of heat in the molten fuel, and the latest calculations say it takes three or four days to penetrate the base mat.

It may be that, as we refine that model, it might not melt through at all, because the rate at the bottom of the 12 feet is already very, very small.

I am hoping that that will be refined in the future, and we may be able to say someday that the core will not penetrate the base mat, and that would be very nice,

because it would keep this molten mass out of the groundwater.

JUDGE COLE: All right, sir. Thank you.

BOARD EXAMINATION

BY JUDGE SMITH:

Q Your reference to Surry and Peach Bottom, it was a reference to the two reactors studied in WASH-1400?

A Yes, that is correct.

JUDGE SMITH: Is there any additional cross examination based on the Board's questions?

MR. THOMAS: Yes, your Honor.

CROSS EXAMINATION

(Continuing.)

BY MR. THOMAS:

Q Picking up on that, in your opinion, is Surry comparable to Byron? Is the reactor at Surry comparable to the reactors at Byron?

A I am not sure what you mean by "comparable."

I think there are differences in design that would make differences in predictions of core-melt probability and predictions of risk.

On the other hand, I believe that the characterization of Byron risks in the FES represents a reasonable approach and yields conservative results.

Q Well, my question was not about the FES.

My question was about the comparison of Byron to Surry in the sense that you have just indicated, I think, that you don't think they are comparable; is that correct?

A I think that Byron would probably have lower -- I am guessing now. I am making an educated guess that Byron would have lower risks than Surry.

Q The reason it's a guess is because you don't know the Byron design; is that correct?

A It's because a PRA hasn't been done on Byron, nor do I think one has to be done as part of a licensing process.

Q As I understand it, you criticize the precursor report in part, saying that it's both generic and unique.

Can't the same criticism be made for WASH-1400?

A It depends on how far down the accident sequence you are going.

If you are going sort of halfway down, I think that's too far.

If you are talking about individual pieces that feed into accident sequence probabilities, I think that's all right; and that's what we did in WASH-1400.

Q You gave a figure of property damage estimated by WASH-1400, I believe, of 14 billion dollars?

A At a probability of, chance of, one in a billion per year.

Q Yes, thank you.

But that was in 1975 dollars; is that correct?

A That was in 1972 or 1973 dollars.
Q 1972 or 1973?
A Yes.
Q Do you have any idea what that would be in 1983 as in WASH-1400?
A You could apply the escalation since then and get a number.
Q I am asking you: Do you know what that is?
A No.

JUDGE SMITH: We just officially notice that it's a lot. It's a substantial degree.

MR. THOMAS: I have no objection to that.

THE WITNESS: I should say that --

MR. THOMAS: Maybe a little technical but --

THE WITNESS: I should say that in 1972 the economic burden of accidents in the U S was 30 billion dollars a year.

BY MR. THOMAS:
Q You are talking about all accidents?
A All accidents.
Q Thank you for that information.

You talk about CRAC 2.

Well, there was CRAC, which was used in 1400; right?

A Yes.
Q Is that a cancer model or how would you characterize that?

A Health effects models in both codes are identical, both CRAC and CRAC 2.

Q What is CRAC? What would you describe that as --

A CRAC is a code that takes as its input the frequency of releases of various -- radioactive releases of various sizes and then calculates the way in which the radioactivity is dispersed in the environment; how much is deposited on the ground, how many people are exposed, the efficacy of evacuation and predicts health effects.

Q I take it you agree with the CRAC model since it was used in WASH-1400?

A We developed it, yes.

Q So you agree with it?

A Yes.

Q Do you agree --

A By the way, I think there were some weaknesses in it.

One weakness was the meteorological sampling, which has been corrected in CRAC, and the other is, I think, a better interpretation of the evacuation data.

Q Do you agree with the -- with CRAC 2?

A Yes.

Q And are you aware that that was used in the Sandia Study?

A Yes.

MR. GALLO: Objection, objection.

I have listened patiently to these questions on CRAC

and CRAC 2.

It was my understanding that the further cross examination was to be based upon the questions and answers elicited by the Board.

If my recollection is correct, Mr. Thomas is now following up on the cross examination of Mr. Campbell, who was following up on the cross examination of Mr. Thomas, and I don't think this further line of questioning should be allowed.

MR. THOMAS: Judge --

JUDGE SMITH: Well, the problem, Mr. Gallo, is that sooner or later he is going to be allowed to follow up on any cross examination or redirect examination that affects his interests, that is otherwise reasonable.

I misstated the opportunities, because it has always been the Board who has introduced new information; but this is the first time it has come up in this hearing that another party has introduced information.

So that is correct as far as the Board's ruling was concerned, but the Board's ruling was wrong.

MR. THOMAS: Well --

JUDGE SMITH: You may continue.

MR. THOMAS: Okay. Did you answer --

THE WITNESS: What was the question?

BY MR. THOMAS:

I think you answered it.

But the question was whether you were aware that CRAC 2 was the model used in the Sandia Report.

A Oh, yes, yes, I was; but I do agree with the way it was applied.

Q Thank you. You have answered the question.

Now, as I read your definition of Class 9 accidents, which I take it is based on the NRC definition, part of that definition is accidents beyond the design base; right?

A Yes.

Q Now, does that include safety systems, too; in other words, the safety systems in the design base?

A I am not sure what your question is, but let me try to answer it anyhow.

Q Let me try to put a question which you are sure about --

JUDGE SMITH: You --

MR. THOMAS: I am sorry.

JUDGE SMITH: Go ahead. Continue this.

BY MR. THOMAS:

Q Well, where I am heading is that if the definition of Class 9 is accidents beyond the design base, which includes the safety systems in that design base, then by definition, a Class 9 accident, you know, is one beyond the safety systems which have been designed into the

plant; is that correct?

A I don't -- I guess I don't understand the question, and, therefore, I find it very difficult to answer. I --

Q All right. Don't answer a question that you don't understand.

It's up to me to put a question which you can understand.

Part of the design base is the safety systems; is that correct?

A Yes.

Q And that holds true for purposes of the definition of Class 9 accidents?

A Well, not necessarily. In Three Mile Island an accident happened in which a relief valve stuck open and was handled improperly and the relief valve is not in the design basis accident parlance.

Now, it did result in a small loci, which is -- but all the other safety features worked correctly and had the operators not turned them off at the wrong times and so forth, it would have been all right.

Q Yes, right; but they did?

A They did.

Q With regard to the WASH-1400, did that study contain as a part of the study a more or less self-imposed five-year limit on the validity of the results?

A They did that. We were not want to extrapolate the results beyond five years.

Q And that would have expired beyond October, in October of 1980; is that correct?

A (Indicating.)

Q You have to --

A Yes.

MR. THOMAS: That is all I have, Judge.

JUDGE SMITH: Do you have questions?

MR. RAWSON: Yes, Judge, I have just one more.

CROSS EXAMINATION

(Continuing.)

BY MR. RAWSON:

Q Mr. Levine, a few moments ago, in response to a question from Mr. Thomas, you said it was your educated guess that Byron would have lower risks than Surry.

Do you recall that statement?

A Yes, sir.

Q When you used the term "risk" in that answer, did you mean a lower probability of occurrence of releases or did you have something else in mind?

A I meant really lower probabilities of occurrence.

MR. RAWSON: That is all I have, Judge. Thank you.

JUDGE SMITH: Mr. Gallo.

MR. GALLO: Mr. Levine, I have a series of questions on redirect.

REDIRECT EXAMINATION ON BEHALF OF COUNSEL FOR APPLICANT

BY MR. GALLO:

Q First of all, just now in answer to one of Mr. Thomas' questions, you indicated there was a five-year limit set forth in WASH-1400 in terms of extrapolating the results of that document; is that correct?

A Yes.

Q And that that five-year limit has expired; is that correct?

A Yes.

Q Well, does that then -- does the expiration of that limit invalidate the use of WASH-1400 by the Staff in the FES?

A Not at all.

Q Would you explain why not?

A Yes. We -- I guess I was responsible for writing that and I can tell you what I had in mind.

I had in mind that there would be an additional large number of reactors operating over and above the, I think, 27 that were operating when we did WASH-1400. These would be of more advanced design, would have different risks, and, therefore, to extrapolate WASH-1400 to these newer reactors would probably be too

conservative.

On the other hand, the fact that the Staff has re-examined and redefined a source term, generally applicable conservative source term, based on WASH-1400 and other considerations that have happened since WASH-1400, I feel it's still useful to use that source term for FES purposes and that our limitation, our five-year limitation, had nothing to do with the application of WASH-1400 methods. We felt the methods would be improved with time and they should be used in appropriate ways.

Q Mr. Levine, in answer to one of Mr. Thomas' earlier questions, he directed you to Page 4 of your testimony.

He called your attention to the use of the term, "deterministic methodology."

I believe you answered that or -- strike that.

I believe he then asked you whether or not deterministic methodology essentially involved engineering opinion; and you agreed with him.

Do you recall that?

A Yes.

Q What did you mean when you agreed with the term "engineering opinion"?

Is such an engineering opinion a rigorous exercise?

A It's not rigorous of quantitated probability estimates,

but it has great value. Most engineering designs in this world are accomplished on the basis of the wisdom and engineering judgment of skilled people.

He wanted to -- I have the word "judgment" in my testimony. He wanted to make it opinion. Well, you know, informed opinion is judgment, so I had no quarrel with the word "opinion." I think it would be wrong to denigrate the use of engineering judgment. In fact, it's engineering judgment that have produced reactors that yield these very small risks to people and have put men on the moon.

JUDGE SMITH: May I interpose a question along that line?

MR. GALLO: Yes.

JUDGE SMITH: Would you prefer not?

MR. GALLO: No. Go right ahead.

BOARD EXAMINATION

BY JUDGE SMITH:

Q When you say we use "deterministic approach" or "engineering judgment," instead of a "probabilistic approach," don't engineers, either more or less formally, use probablistics as a part of engineering judgment?

A Yes. They make the -- they make their probabilistic judgments unquantitatively. That is, they say for instance, "I think in designing reactors we can design

reactor vessels whose probability of failure is so small that we do not have to consider it in the design basis."

Then along comes some probabilistic people who say, "Well, we can estimate the probability that that vessel will fail and we put it into our PRA and we find that it's not very important." It doesn't make the risks overwhelmingly common, and that confirms their engineering judgment.

In the larger sense, the fact that we have now done a significant number of PRA's on a significant number of plants, and the risks are all quite small, confirms the years of engineering judgment applied to the design of reactors.

BY MR. GALLO:

Q I believe Mr. Campbell asked you a couple of questions about the Commission policy statement that you refer to on Page 11 of your testimony.

If I understood the testimony as elicited by Mr. Campbell, you were agreeing that the Commission had essentially disowned the use of WASH-1400 at the time of a policy statement in 1979.

Is that a fair understanding on my part?

A Not quite. He read certain quotes from that policy statement, which I recalled as being roughly correct and I agreed that those were from the policy statement.

On the other hand, he didn't read other things in the policy statement that were very important.

On Page 11 of my testimony I quote from that same Commission statement, and I will just read it here.

"Taking due account of the reservations expressed in the Review Group Report" -- and the review group report is --

MR. THOMAS: For the record, I object. First of all, I think they were my questions, but that's irrelevant.

I object to him simply re-reading from his direct testimony and I don't think --

MR. GALLO: I will instruct the witness to merely characterize his testimony and not just read it by rote into the record if that will satisfy your objection.

MR. THOMAS: That is part of it.

I also didn't feel that it was within the scope of the question and, therefore, I would object to it as irrelevant in that sense.

MR. GALLO: Well, the question essentially inquired as to whether or not the quotations apparently elicited by Mr. Thomas were properly interpreted as meaning that the Commission had invalidated or said in its policy statement that the use of WASH-1400 was no longer appropriate and invalid.

He was about to -- then he disagreed with that

interpretation; and then I asked him to explain the basis for that and he was about to do that by reading a quote from Page 11 when he was interrupted, so I think it's well within the scope of the question.

JUDGE SMITH: Not only that, but I really didn't see anything wrong with him reading verbatim from his direct testimony if that's the most accurate and best way that he can do it to get it into the context of this part of the testimony.

MR. THOMAS: Well, I guess my objection really goes to the form of the question, because he simply did read quotes, which he said didn't take place; but I certainly didn't characterize them the way Mr. Gallo is characterizing them.

JUDGE SMITH: Now, that is a different objection.

MR. THOMAS: Yes, I agree, that is a different objection, I agree.

MR. GALLO: That objection has been waived. We are past that question.

He is now explaining how my understanding is incorrect.

So it's too late to object to that.

JUDGE SMITH: Well, there will be other opportunities, perhaps; but, in the meantime, the question --

you can continue your answer; but you better --

THE WITNESS: Shall I characterize rather than quote? I will be happy to do either.

JUDGE SMITH: You do it the best way that can be done accurately and succinctly.

A (Continuing.) Okay. I think the Commission policy statement ended with the exhortation that "the Commission supports the extended use of probabilistic risk assessment in regulatory decisionmaking" and questions that one be cautious about the reservations expressed by Lewis.

Furthermore, since that time the Commission has made a number of -- the Chairman and the Commission has made a number of statements that show continued strong support for the use of these techniques in the regulatory decisionmaking.

One such example is a letter from the Chairman of the Commission to the Executive Director for Operations instructing that cross benefit analyses in PRA be used by the Generic Requirements Review Committee.

Another statement is in the safety goal policy paper, NUREG 0880, which says there has been both significant progress in the development of PRA techniques to make it feasible to use quantitative reactor safety guidelines at this time for limited purposes.

And in connection with the NEPA requirement, the

requirement for consideration of Class 9 accidents in NEPA, the Commission again directed the use of attention to both probability of occurrence and consequences of radioactive releases in the filing of Class 9 portions of environmental impact statements.

So what has happened since the Lewis Report, both at the time of the Lewis Report and since the Lewis Report, is a strong representation by the Commission to continue to use these techniques in the best possible way to aid in safety decisionmaking.

One can't live with 1979 statements in 1982.

BY MR. GALLO:

Q Mr. Levine, I believe you indicated in answer to one of the questions that was asked, that evacuation measures and techniques were not very efficient but they were useful nonetheless.

Is that correct?

A Yes.

Q Why doesn't that affect the risk in PRA's, such as, say, the WASH-1400?

A It did. It affected it. It caused a reduction in the largest values predicted for early fatalities by a factor of two.

Q How significant is that?

A Well, if you believe the factor of two, it is significant.

If you look at the uncertainties involved with such predictions, where they may be off by a probability by a factor of ten, it is not very important. You have to make a judgment about this. I think it's important to have good evacuation plans.

Q But the infirmities of evacuation, were they taken into account in WASH-1400?

A Yes. I described the models used in WASH-1400.

Q And did the Staff equally take that into account in the FES writeup?

A Yes, yes.

MR. THOMAS: Objection, objection. I don't know how this witness has a foundation to know what Staff did with the evacuation infirmities in terms of FES other than, perhaps, what is printed in the FES itself.

I just don't think there is any foundation for him to answer the question as posed.

MR. GALLO: This witness' testimony said that he has examined and studied the Staff writeup in the FES, beginning -- this discussion is in his direct testimony, beginning on Page 16.

I believe that lays the foundation for him to be able to testify with respect to what the Staff did or didn't do with respect to evacuation models in coming up with their risk assessments.

MR. THOMAS: Judge, it's purely hearsay. All he knows is what the Staff wrote on FES. The Staff could have written, you know, grass is yellow; and -- that's not a good example; but all he knows is what they wrote. So to ask him what the Staff did I just don't think is proper.

MR. GALLO: Shall I respond to that, your Honor?

JUDGE SMITH: Yes.

MR. GALLO: Well, the hearsay is not a proper objection. The document is an official document of the Agency and it can be relied upon by another scientific expert for purposes of drawing his opinion.

In fact, he has been testifying about such matters with respect to the Sandia Report, the precursor report, and it now seems to me to be a little inconsistent that Mr. Levine cannot comment on the FES.

So I believe the hearsay objection is simply not well taken.

JUDGE SMITH: It's not hearsay, in the sense that he is telling you what he relied upon.

MR. THOMAS: Right.

JUDGE SMITH: If the basis of -- if the data upon which he relied upon is not reliable, why, then, you have another argument; but --

MR. THOMAS: Well, I think it still is heresay;

but in that sense I suppose it's not used for the truth of the matter asserted; but the question is what did the Staff do. That's what the question is when it's boiled down to.

JUDGE SMITH: There is a slight understanding. What is your understanding of what the Staff had done, you have no objection?

You are going to have to hear from Staff.

MR. THOMAS: I know. That is why I would like to get the testimony from the Staff as opposed to somebody who doesn't know what the Staff did.

MR. GALLO: That has not been established of the record. I think the testimony of the witness is he does understand the methodology and assumptions used by the Staff, and how they dealt with the emergency and evacuation matters seems to me is one subject that he has knowledge with respect to and he should be entitled to testify to it.

After all, this witness' bottom-line testimony is that the Staff's analysis in the FES is adequate.

JUDGE SMITH: Okay. However, we are going to then allow Mr. Thomas to examine him some more and I think we have already digressed and we have become watered down on this point beyond its importance, I may say.

MR. THOMAS: I agree with that.

JUDGE SMITH: Proceed. You may answer.

A My understanding is that the Staff used the model of CRAC that is somewhere in between the WASH-1400 CRAC and CRAC 2.

That it includes the CRAC 2 evacuation plan, I believe, as opposed to the CRAC evacuation plan; and that's the basis on which I endorse their findings about the FES and the FSAR.

BY MR. GALLO:

Q Mr. Levine, I believe, in answer to one of Mr. Thomas' questions, you indicated that you had not read the FSAR.

Is that correct?

A Yes.

Q Is reading the FSAR necessary to the preparation of your testimony in this case?

A No. If I felt it had been, I would have read it.

I believe that what we are discussing here are analytical methods and their meaning as opposed to specific design details of the Byron plan.

Now, in a few cases where they were important, I have talked about them; and I gained my knowledge of them from the SER filed by the NRC Staff.

Q I believe you also indicated that you had not visited the Byron site; is that correct?

A That's correct.

Q And that you had not read the Byron operating procedures; is that correct?
A That is correct.
Q And that you had not conducted any control room analysis or any other analyses?
A That is correct.
Q Are all of these things necessary to your testimony?
A No, they are not. Again, we are talking here about principally analytical methods and their validity and the specific details of the Byron plant are not very important.

MR. GALLO: That is all I have, your Honor.

JUDGE SMITH: Is there any additional cross examination?

MR. THOMAS: No.

JUDGE SMITH: Anything further, Mr. Rawson?

MR. RAWSON: No.

JUDGE SMITH: Okay. Now, we just have this remaining item, and that is that Mr. Levine is going to examine the testimony when it's prepared and I think it would be, if possible -- will you be here tomorrow?

THE WITNESS: Yes.

JUDGE SMITH: I think it would be very helpful if he would do that as early as possible, so he would be available to comment on any corrections that he thinks are

necessary when this same group of people are present in the room.

So with that we wil ask you to step down and we will begin with the Staff's witnesses, after the afternoon break.

(Witness excused.)

(Recess.)

JUDGE SMITH: The witnesses have been sworn. Dr. Branagan was previously sworn.

MR. THOMAS: Judge, may I raise one point that is on my mind before we get into the testimony of these witnesses?

JUDGE SMITH: Yes.

MR. THOMAS: I, prior to the beginning of the hearings, received a document from Mr. Gallo with a cover letter indicating that it was going to the Board, which filed a document which purportedly was a PRA regarding Byron.

Now, it's my understanding that the Applicant does not proceed to introduce that into evidence in this proceeding, and that it would not be a part of the official record, and I understand why they do it under their interpretation of the McGuire case, I guess; and I don't know enough about that case to object to the filing of the document; but I just wish to make sure for

purposes of the record that that, you know, material is -- well, it's sort of in limbo. It's not part of the record and I know the Board will not consider something which is not into evidence; but I, you know, just wish to raise the matter on the record, so that we can, well, just make it of record.

JUDGE SMITH: That is very appropriate and I am sure you are aware that the Administrative Procedure Act and Commission's regulations require us to make our decisions based on nothing except the evidentiary record; and unless it somehow happens to get its way into evidence, it will never be heard of again in this proceeding.

MR. THOMAS: All right. As I said, I just wanted to make a record on that before it slipped my mind.

JUDGE SMITH: Mr. Rawson.

MR. RAWSON: At this time, Judge Smith, witnesses L. G. Hulman, Millard Wohl, Scott Newberry and Dr. Edward F. Branagan, Jr., and I have supplied the reporter with a copy of their testimony with certain corrections and also a chart which will make it easier for the reporter.

L. G. HULMAN

MILLARD WOHL

SCOTT NEWBERRY

EDWARD F. BRANAGAN, JR.

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

DIRECT EXAMINATION

BY MR. RAWSON

Q Gentlemen, would you each please state your names?

A (WITNESS NEWBERRY) My name is Scott Newberry.

A (WITNESS HULMAN) Lewis Hulman.

A (WITNESS WOHL) My name is Millard Wohl.

A (WITNESS BRANAGAN) I am Edward F. Branagan, Jr.

Q Would you please state by whom you are employed and in what position?

A (WITNESS NEWBERRY) I am employed by the Nuclear Regulatory Commission, Reliability Risk and Assessment Branch, where I am a risk analist.

A (WITNESS HULMAN) I am employed by the Nuclear Regulatory Commission. I am Chief of the Accident Evaluation Branch.

A (WITNESS WOHL) I am a nuclear engineer in the Accident Evaluation Branch of NRC.

A (WITNESS BRANAGAN) I am a health physicist in the Radiological Assessment Branch of NRC.

Q Do you have before you a copy of the testimony of L. G.

Hulman, Millard L. Wohl, Scott Newberry and Edward F. Branagan, on League Contention 8, 62 and DAARE/SAFE Contention 2-A?

A (WITNESS NEWBERRY) Yes.

A (WITNESS HULLMAN) Yes.

A (WITNESS WOHL) Yes.

A (WITNESS BRANAGAN) Yes.

MR. RAWSON: For the record of the Board, that testimony consists of 22 questions, the respective professional qualifications of the witnesses and attachments A, B and C.

BY MR. RAWSON:

Q Gentlemen, were each of you responsible for the preparation of the portions which bear your name within the questions and answers?

A (WITNESS NEWBERRY) Yes.

A (WITNESS HULMAN) Yes.

A (WITNESS WOHL) Yes.

A (WITNESS BRANAGAN) Yes.

Q Are there changes or corrections to be made to the testimony?

A (WITNESS HULMAN) Yes.

Q Are those changes or corrections as have been marked on the master copy given to the Court Reporter?

A (WITNESS NEWBERRY) Yes.

A (WITNESS HULMAN) Yes.
A (WITNESS WOHL) Yes.
A (WITNESS BRANAGAN) Yes.

MR. RAWSON: Judge, I don't know for the purposes of the Board if the Board desires to have the change of substance on the record in addition to off the record?

JUDGE SMITH: I see nothing that is gained by that. It's in the transcript. That's where it belongs. I mean it's in the testimony itself and that's where it belongs.

BY MR. RAWSON:
Q Gentlemen, with respect to the professional qualifications attached to your testimony, are those professional qualifications true and correct?
A (WITNESS NEWBERRY) Yes.
A (WITNESS HULMAN) Yes.
A (WITNESS WOHL) Yes.
A (WITNESS BRANAGAN) Yes.
Q With the corrections that have been submitted with your prefiled testimony, is that testimony true and correct and do you adopt it as your testimony in this proceeding?
A (WITNESS NEWBERRY) Yes.
A (WITNESS HULMAN) Yes.
A (WITNESS WOHL) Yes.

A (WITNESS BRANAGAN) Yes.

MR. RAWSON: Judge Smith, at this time we would ask that the testimony be submitted and bound into the transcript as if read.

MR. GALLO: No objection.

MR. THOMAS: No objection.

JUDGE SMITH: The testimony is received.

(The document referred to, the prepared testimony of L. G. Hulman, Millard L. Wohl, Scott Newberry and Edward F. Branagan, J., received in evidence, follows:)

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454
	)	50-455
(Byron Station, Units 1 and 2)	)	

TESTIMONY OF L. G. HULMAN, MILLARD L. WOHL, SCOTT NEWBERRY AND EDWARD E. BRANAGAN ON LEAGUE CONTENTIONS 8 AND 62 AND DAARE/SAFE CONTENTION 2A

FR.

Summary

The following testimony addresses League Contentions 8 and 62 and DAARE/SAFE Contention 2a which relate generally to the subject of risk and accident impacts. The principal points made in the testimony are as follows:

1. The Final Environmental Statement for Byron Station contains a reasoned consideration of environmental risks from the plant, including risks resulting from postulated accidents.

2. The overall assessment of environmental risk of accidents shows that it is roughly comparable to the risk from normal plant operation.

3. The probabilistic risk assessment methodology of WASH-1400 has been used by the Staff in the preparation of the FES and is sound for the purposes for which used.

4. The Precursor Study results do not necessarily imply that WASH-1400 estimates do not currently apply to a large class of plants and do not invalidate those estimates with respect to their use in the Byron FES.

5. Adequate protection against potential accidents has been provided at Byron Station through the Commission's licensing requirements and additional measures.

6. The possibility of cumulative doses to residents of the Illinois area from accidents at more than one nuclear power plant does not create undue risk to public health and safety.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454
	)	50-455
(Byron Station, Units 1 and 2)	)	

NRC STAFF TESTIMONY OF L. G. HULMAN, MILLARD L. WOHL, SCOTT NEWBERRY AND EDWARD F. BRANAGAN, JR. ON LEAGUE CONTENTIONS 8 AND 62 AND DAARE/SAFE CONTENTION 2A

Q.1 Please state your names and positions with the NRC?

A.1 (Panel)

I, L. G. Hulman, am Branch Chief, Accident Evaluation Branch, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.

I, Millard L. Wohl, am a nuclear engineer in the Accident Evaluation Branch, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.

I, Scott Newberry, am a Risk Analyst in the Reliability and Risk Assessment Branch, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.

I, Edward F. Branagan, Jr., am a Health Physicist in the Radiological Assessment Branch, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.

Q.2 What is the purpose of your testimony?

A.2 (Panel)

The purpose of this testimony is to provide the Staff position in response to League Contentions 8 and 62 and DAARE/SAFE Contention 2A relating generally to Class 9 accident analysis. (Copies of those contentions are provided as Attachment A to this testimony.)

Q.3 With respect to League Contention 8, has the risk from operation of Byron Station been assessed by the Staff?

A.3 (Wohl, Hulman)

Yes, the Final Environmental Statement for Byron Station (NUREG-0848), in Section 5.9.4, contains a reasoned consideration of environmental risks from the plant, including risks resulting from postulated accidents. That section of the FES was prepared by the Accident Evaluation Branch and we adopt it as part of our testimony here. Attention is given there both to the probability of occurrence of radioactive releases and to the probability of occurrence of the environmental consequences of those releases via atmospheric and groundwater pathways, as required by the Commission's Statement of Interim Policy, dated June 13, 1980, on "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969." (Attachment B)

Q.4 What has the Staff concluded with respect to the overall assessment of risk of accidents at Byron Station?

A.4 (Wohl)

The overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable to the risk from normal operation although accidents have a potential for early fatalities and economic costs that cannot arise from normal operations. The risks of early fatality from potential accidents at the site are small in comparison with risks of early fatality from other human activities in a comparatively sized population. FES § 5.9.4.6.

Q.5 In preparing the FES, did the Staff consider accident risks that could be caused by external natural and man-caused events such as tornadoes, fires, earthquakes and sabotage?

A.5 (Hulman, Wohl)

Yes, but only qualitatively.

Q.6 Please explain.

A.6 (Hulman, Wohl)

In Section 5.9.4.5(2) of the FES, reference is made to natural phenomena and sabotage, but no reference is made to other man-caused risks such as from explosions or airplane crashes. All natural and man-caused events, including fires, are referred to by the Staff as external events.

With respect to this case, no quantitative assessment of accident risks from external events has been made. The only cases for which external natural events have been assessed in detail are for the Zion and Indian Point reactors. For Zion, the licensee has submitted a Probabilistic Risk Assessment which indicates external events can be significant contributors to risk. For Indian Point, evaluations by the Staff also indicate significant risks due to external events. By significant, we mean that the best estimates of the additional risk from external events were shown to be as much as about a factor of 30 higher compared to the best estimate risks from internal events at Indian Point, but about 10 times the best estimate risk from internal events at Zion.

In preparing the FES for this case, the Staff made no numerical assessment of accident risks from external events at Byron, but did draw upon information obtained from the Zion and Indian Point studies for estimates in the Byron FES. That is, the Staff's best estimate of accident risks from external causes, based upon what has been learned at Zion and Indian Point, could be higher than what has been presented in the FES, but may be in the range predicted for Indian Point and Zion.

Q.7 To what extent is the generic subject of external events under consideration by the Staff?

A.7 (Hulman, Wohl)

The Staff has long recognized that the accident risks from external events can be significant. In developing criteria for the design of nuclear power plants, the Staff has developed considerable guidance for the treatment of the subject within design bases in order to reduce substantially the risk from external events. However, the current Staff assessment of the state of the art of consideration of external event PRA methodology is that it is not sufficiently mature to produce reliable absolute estimates of risk. In other words, there are many uncertainties associated with absolute estimates obtained using current methodology; however, the estimates can often yield valuable insights if used in a relative sense. The Staff is undertaking the development of a program plan for improving the capability of external events PRA methodology. This plan is expected to be completed by early summer, 1983 and is expected to be implemented over the next 2 to 3 years. The plan is directly related to Commission planning guidance presented in NUREG-0885, Issue 2 "U.S. Nuclear Regulatory Commission Policy and Planning Guidance - 1983."

Q.8 How does this compare with the guidance promulgated in the June 13, 1980 Statement of Interim Policy?

A.8 (Hulman, Wohl)

We consider this responsive in view of the state-of-the-art in quantatively assessing accident risks from external events.

Specifically, we conclude that external events can be contributors to risk, but that the state-of-the-art in quantifying the likelihood of such events, and associated uncertainty, is not well developed.

Q.9 Was the methodology of the Reactor Safety Study, WASH-1400, used in the preparation of Section 5.9.4 of the FES?

A.9 (Wohl)

Yes, the probabilistic risk assessment methodology of WASH-1400 was used by the Staff in the preparation of Section 5.9.4 of the FES. Probabilistic discussion of the environmental risks attributable to accidents at nuclear power reactor facilities is called for by the Commission's June 13, 1980 Statement of Interim Policy.

Q.10 Has the methodology of WASH-1400 been called into question since publication of that document?

A.10 (Wohl)

No. The Independent Risk Assessment Review Group stated in the Lewis Report (NUREG/CR-0400) that it was unable to determine whether the overall core-melt probability given in WASH-1400 was high or low, and concluded that the error bands were understated. It also stated that it was difficult to follow the detailed thread of calculations through the WASH-1400.

The group also determined, however, that the probabilistic methodology employed was an important advance over earlier methodologies that had been applied to reactor risk, and was sound. It stated that the fault-tree/event tree approach, coupled with an adequate data base, is the best available tool with which to quantify the accident probabilities associated with nuclear reactors. This approach was applied to a prototype pressurized water reactor (Surry) and led to the establishment of probabilities for core melt accidents and resulting release of large amounts of radioactive materials which were used as surrogates in the Byron FES.

With respect to the findings of the WASH-1400, the Commission has recently stated that it accepts the Review Group Report's conclusion that "absolute values of the risks presented by WASH-1400 should not be used uncritically either in the regulatory process or for public policy purposes and has taken and will continue to take steps to assure that any such use in the past will be corrected as appropriate." Letter, dated December 27, 1982, from Acting Chairman Ahearne to Congressman Udall (Attachment C). The letter also states that "Taking due account of the reservations expressed in the Review Group Report and in its presentation to the Commission, the Commission supports the extended use of probabilistic risk assessment in regulatory decisionmaking."

The use of probabilistic risk assessment techniques used in generating the estimates of environmental consequences of radioactive releases (FES Section 5.9.4) fulfills the requirements of the Commissions Statement of Interim Policy of June 13, 1980 with respect to NEPA accident review. The methods employed in the analyses performed for the Byron Station FES based upon WASH-1400 methodology have uncertainties associated with them. These are discussed in Section 5.9.4.5(7) of the Byron Station FES. The environmental consequences estimation in the FES takes into account significant site-specific features such as sector-dependent population, meteorology, and land fraction data surrounding the site.

Q.11 What is the Precursor Study?

A.11 (Newberry)

The "Precursor Study", or more accurately, "Precursors to Potential Severe Core Damage Accidents: 1969-1979 A Status Report," (NUREG/CR-2497) is a report which presents the initial results of a program performed at Oak Ridge National Laboratory and administered by the Nuclear Regulatory Commission. The program uses operational data in Licensee Event Reports to evaluate potential accident precursors occurring at operating reactors. These precursors are then summarized to derive a probability for severe core damage.

Q.12 Does the Precursor Study imply that WASH-1400 estimates may not currently apply generically to a large class of plants?

A.12 (Newberry)

The Precursor Study estimated the frequency of severe core damage accidents (averaged over all domestic light water power reactors in the decade of the 1970's) to have been between 1.7 x 10^{-3} and 4.5 x 10^{-3} per reactor year. In WASH-1400, the core melt frequency for the Surry plant (taken to represent pressurized water reactors) was estimated to be 5 x 10^{-5} per year. We do not differentiate between severe core damage and core melt in this testimony since analyses have not been refined to differentiate the fraction of POTENTIAL core melt ~~events~~ ACCIDENT SEQUENCES that ~~may~~ ARE terminate at severe core damage. While this difference appears to be substantial, it does not necessarily imply that the WASH-1400 results do not currently apply to a large class of plants.

FROM THOSE ACCIDENT SEQUENCES THAT PROCEED TO CORE MELT.

Q.13 What are the reasons for this difference in frequency estimates?

A.13 (Newberry)

As stated in the Precursor Study, 82% of the precursor estimate of severe accident frequency comes from three events: Three Mile Island accident, the Browns Ferry fire and the Rancho Seco power supply failure. These events were not explicitly addressed in WASH-1400.

While WASH-1400 did treat most elements of the TMI accident, it did not treat the possibility that the reactor operators might misdiagnose an accident in progress and turn off the safety systems that were necessary to cool the core. This event (TMI) is the most important of the three and it is the only actual instance of severe core damage.

Fires were not included among the accident initiators in WASH-1400.

The Rancho Seco event was caused by a power supply fault. A comprehensive analysis of the fault effects and systems interactions originating in power supplies for control and instrumentation was not done in WASH-1400.

Q.14 Why do these omissions in WASH-1400 not invalidate the severe core damage frequency estimates today with respect to their use in the Byron FES?

A.14 (Newberry)

Since the Three Mile Island accident, regulatory requirements have been implemented to reduce the likelihood that operators might fail to diagnose inadequate core cooling. These requirements include training procedures and new and improved instruments to aid in event diagnosis. Therefore, operator errors of this type are less likely today than they were before the TMI accident. In addition, the accident initiator

(transient induced LOCA) that occurred at TMI is less likely at a Westinghouse plant like Byron because the pressurizer power operated relief valve(s) is not likely to open during feedwater transients.

Following the Browns Ferry fire, fire protection requirements were developed in a new rule, Appendix R to 10 CFR 50. Byron is being ~~is being~~ reviewed against the requirements of this rule. See SER § 9.5.1.

The Rancho Seco power supply failure was significant from the standpoint that the power fault caused a loss of main feedwater, affected the auxiliary feedwater controls and caused erroneous information to be sent to the operator regarding the need to manually initiate auxiliary feedwater or the emergency core cooling system. Plants studied in WASH-1400 and Byron do not appear to be as vulnerable to such faults as Rancho Seco. Additionally, Byron will have safety-related actuation for the emergency feedwater system (as well as for other engineered safety features) so that a fault in the nonsafety-related feedwater control system should not defeat the autostart of the auxiliary feedwater system. Byron will also have safety-related auxiliary feedwater flow indication and steam generator level indication in the control room, so that failures like that at Rancho Seco should not impair the operator's ability to monitor plant status.

Loss of feedwater events were the fourth dominant contributor to severe core damage in the precursor study. Auxiliary feedwater system reliability was found to be poor and no credit was given for feed-and-bleed cooling.[1/] This is a possible source of conservatism, but there were no procedures in place for feed and bleed cooling, and the staff has not yet made a complete evaluation of this mode of cooling.

WASH-1400 did not give credit for feed and bleed; however, there is some likelihood that it could be used to prevent severe core damage. Since Three Mile Island additional requirements have been implemented on all reactor plants to improve auxiliary feedwater system reliability. These requirements and the Staff evaluation can be found in Section 10.4.9 of the Byron Safety Evaluation Report.

In summary, the use of WASH-1400 core melt frequency estimates is not invalidated by the precursor study.

Q.15 Does probabilistic risk assessment provide the basis for decisions concerning safety in the licensing of Byron Station?

1/ "Feed and bleed" refers to a mode of core cooling in which all feedwater (main and auxiliary) is not available, and decay heat removal is accomplished by adding coolant inventory with the high pressure injection system and removing decay heat energy through the safety or relief valves.

A.15 (Wohl)

No. The probabilistic risk assessment approach is used by the Staff in assessing environmental impact of power reactor operation under the June 1980 Statement of Interim Policy. Licensing considerations have rested, and continue to rest, upon an applicant's compliance with the Commission's deterministic licensing criteria. Performance of a plant-specific PRA is not a licensing requirement for Byron Station.

Q.16 What is the meaning of the term "Class 9" accident or event as used in League Contention 62?

A.16 (Wohl)

The term "Class 9" event is derived from a proposed rule change published by the AEC in 1971. The proposed rule change, which has now been withdrawn by the NRC, set forth a system of classification of potential accidents for use in Staff NEPA assessments. It set forth a spectrum of accidents consisting of nine classes ranging from the most trivial to the most severe for purposes of evaluating environmental risk.

Class 9 events were characterized as ". . . involv(ing) sequences of postulated successive failures more severe than those postulated for the design basis for protective systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low." Defense

in depth, constituted by such multiple physical barriers as fuel clad, pressure vessel and containment, is an important design philosophy instituted to provide and maintain the required high degree of assurance that the environmental risk is extremely low.

Since the mitigation features of nuclear power plants have been designed to avoid breach of containment and core melt accidents, occurrences of these accidents involve sequences of failures and have been designated Class 9 events. The term "Class 9" has often been considered synonymous with accidents involving severe release of radioactive material to the environment, but such use is imprecise since the term "Class 9" is much more inclusive. Class 9 events could have radiological consequences ranging from benign to severe. For example, core damage events not involving loss of containment integrity would have fairly limited radiological consequences.

Q.17 Have there been any examples of beyond design basis, or "Class 9" accidents?

A.17 (Wohl)

In considering the facts available regarding the accident at Three Mile Island, the Staff concluded[2/] that the Three Mile Island accident ". . . involved a sequence of successive failures (i.e., small break loss-of-coolant accident and failure of emergency core cooling system) more severe than those postulated for the design basis of the plant" and thus judged that the occurrence at Three Mile Island was a Class 9 accident.

On the other hand, measurements have shown that at no time during or following the accident at Three Mile Island were the radiological consequences to the public severe.[3/] The radioactive material actually released to the environment during the accident at Three Mile Island represented a minimal risk to the public health and safety.

Q.18 What, if any, measures have been taken at Byron to protect the public health and safety against "Class 9" accidents?

2/ NRC Staff response to Board Question No. 4 regarding the Occurrence of a Class 9 Accident at Three Mile Island, in the Matter of Public Service Electric and Gas Company, August 24, 1979.

3/ Ad Hoc Interagency Assessment Group, "Population Dose and Health Impact of the Accident at the Three Mile Island Nuclear Station. NUREG-0559, May 1979.

A.18 (Wohl)

The Byron plant and its various safety systems are analytically tested for adequacy of performance against a series of design-basis events (DBE). Each of these events imposes severe performance demands on the various safety systems which must function in response to such events to enable the plant design to satisfy regulatory requirements. Each of the events is analyzed using conservative assumptions regarding equipment availability and performance capability which are described in detail in the Staff's Standard Review Plan. Thus, the plant is tested not only against a set of challenges to its safety but under additional conservative assumptions regarding plant conditions before and during these challenges. This results in a design capability with multiple and redundant systems for coping with very severe performance demands, and provides substantial protection against unforeseen events involving multiple equipment failures and operator errors.

The Applicant is developing Emergency Response Guidelines which will consider multiple failure events. In addition to the design basis events, analyses assuming various event sequences (including multiple failures) that could occur and fall outside of the required design envelope have been utilized in the preparation of the emergency operating procedures. This approach for the operators is a result of the lessons learned from the TMI-2 accident. Its objective is to

further assure that the operator is able to respond to the complete spectrum of possible events.

A margin for overall safe response to unforeseen events is provided by the flexibility incorporated in many systems and in the multiplicity of installed systems in a nuclear power plant. The plant is designed to tolerate unforeseen event sequences by appropriate use of installed dedicated emergency safety features and other equipment not considered in analysis of the DBE's. For example, alternative systems configurations may be employed or equipment may be manually actuated if automatic logic circuits do not trigger actuation.

The source terms used in offsite radiological consequence analyses for many of the DBE's for Byron are based on the conservative assumptions that 100 percent of the core noble gas inventory and 25 percent of the core iodine inventory are available for release to the containment atmosphere. During the TMI-2 accident, for example, analyses of air samples indicated that a whole body dose of about 100 mrem and thyroid dose of about 15 mrem, both very small fractions of the 10 CFR Part 100 offsite radiological consequence guidelines, would have been received by a hypothetical individual at the site boundary. There is, therefore, a spectrum of severe core damage scenarios for which it can be inferred that adequate

radiological protection has been provided, as long as containment integrity is maintained.

Thus, the Byron design provides protection for a wide range of Class 9 events.

Q.19 Have steps been taken since the TMI-2 accident to reduce the likelihood of Class 9 events?

A.19 (Wohl)

Yes. Immediately following the TMI-2 accident, the Staff recognized the need for improvements. A number of bulletins and orders were issued, followed by the systematic formulation of a Task Action Plan containing extensive recommendations related to operator training and procedures, instrumentation, equipment reliability, and additional hardware.

Requirements for licensee review of operating experience, operational quality assurance, verification of management and technical capability, verification of capability for safety review and operational advice, training of operators, review of facility procedures, review of plant maintenance capability, requirement for shift turnover procedures, requirements related to shift manning, requirements for an onsite safety engineering group, systematic assessment of licensee safety programs, requirements for a shift technical advisor all contribute to a reduction in the probability of systems failure and increased

capability to take corrective actions to prevent accidents from becoming more severe.

The effect of these changes is, first, to enhance the maintenance and operation of the systems involved in each step of identified event sequences, thus diminishing malfunction probabilities for the components of these systems. Secondly, they serve to upgrade significantly the ability of the operators and the operating organization to recognize and take the proper remedial action to cope with a malfunction should it occur. There is a combined effect from improvement in both these aspects on each and every step in the event sequence. Thus, the combined impact on the overall chance for successful safe termination of the initiating event is enhanced, and the likelihood of event sequences leading to core melt with concomitant containment failure resulting in 10 CFR 100 guidelines being exceeded is substantially reduced.

In sum, the deterministic licensing requirements, based upon design basis event considerations, knowledge acquired from the TMI-2 accident, mitigative engineered safety features, multiple barriers against post-accident release of radioactivity, and additional measures, such as emergency operator guidelines which allow risk-reducing human intervention in reactor accident situations provide, in the Staff's judgment, reasonable

assurance that the Byron plant can be operated with no undue risk to the public health and safety.

Q.20 With respect to DAARE/SAFE Contention 2A, has the Staff considered the potential radiological impacts of accidents at the Byron Station?

A.20 (Wohl, Branagan)

Yes. The staff has considered the potential radiological impacts on the environment of certain postulated accidents at the Byron station. Calculated population exposures for these events range from a small fraction of a person-rem to about 450 person-rems for the population within 80 km (50 mi) of the Byron station. These calculations for both individual and population exposures indicate that the risk of incurring any adverse health effects as a consequence of these events is exceedingly small. FES § 5.9.4.5(1). The staff also concludes that radiation exposures from design-basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

As stated earlier, the overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable to the risk from normal operation although accidents have a potential for early fatalities and economic costs that cannot arise from normal operations. The risks of

early fatality from potential accidents at the site are small in comparison with risks of early fatality from other human activities in a comparatively sized population. FES § 5.9.4.6.

Q.21 Have accidents at nuclear power plants in the area of northern Illinois caused a radiological dose burden to residents in that area?

A.21 (Wohl)

There has been no measured offsite radiological dose burden to Northern Illinois residents due to accidents at the nuclear power plants in Northern Illinois, either of a discrete or cumulative nature. The likelihood of a severe accident occurring at any of the nuclear power plants in Northern Illinois is sufficiently small that the addition of the Byron plants will not raise this likelihood to a significant level, even in the case of a hypothetical accident induced by an external event.

Further, the likelihood of more than one severe accident at more than one plant with resultant cumulative significant radiological consequences to residents of a specific area is obviously much smaller. Its upper bound is the product of three terms: 1) the already low probability of a severe accident at one plant over its lifetime, 2) the similarly low probability of a severe accident at another plant, and 3) the probability that in each case the radioactive plume will travel

over the specific area of concern, such as the DeKalb-Sycamore or Rockford areas.

Q22. Does the possibility of cumulative doses to residents of the northern Illinois area from accidents at more than one nuclear power plant create undue risk to public health and safety?

A22. (Wohl)

No, for the reasons discussed in the foregoing answers to Questions 20 and 21 relating to DAARE/SAFE Contention 2A.

Q23. Do the Precursor Study results cause a change in the population dose estimates made by the Staff in the FES?

A23. (Wohl)

No, for the reasons discussed in the answers to questions 12-14 above.

LEWIS G. HULMAN
PROFESSIONAL QUALIFICATIONS

I am presently Chief of the Accident Evaluation Branch, Division of Systems Integration, in the Office of Nuclear Reactor Regulation. I was formerly in the Systems Interaction Branch and previously Chief of the Hydrology-Meteorology Branch, in the Office of Nuclear Reactor Regulation.

My formal education consists of study in Engineering at the University of Iowa where I received a BS in 1958, and an MS in Engineering Mechanics and Hydraulics in 1967. The graduate study was under total sponsorship of the Corps of Engineers. In addition, I have taken post-graduate courses in structural engineering at the University of Nebraska, coastal engineering at MIT, hydraulics and sedimentation at Colorado State University, advanced mathematics through the University of California and numerous management, technical and computer utilization courses sponsored by the government. I have had courses in nuclear engineering, hydrology, water resources, dam design, fluid mechanics, engineering construction, soil mechanics, water supply, hydropower development, sedimentation, geology, meteorology, advanced mathematics, groundwater, coastal engineering, and hydrometeorology.

My employment with NRC (formerly AEC) dates from February 1971 primarily in the area of hydrologic engineering with both the Office of Nuclear Reactor Regulation and with Reactor Standards, and for consultation on siting of materials utilization facilities. Assignments were made on both safety and environmental matters. My responsibilities in the licensing review of nuclear facilities were in the areas of site

analysis, flood vulnerability, water supply, surface and groundwater acceptability of effluents, severe meteorologic events and diffusion analyses. In addition, I participated in the development of the technical bases for safety guides and standards, and research identification and analysis in these areas of interest.

I have participated in a number of management and technical activities beyond the general review of nuclear facilities. I was the agency representative on the Hydrology Committee of the U.S. Water Resources Council, the agency alternate representative on the U.S. Geological Survey Federal Advisory Committee on Water Data and have served on several agency internal task forces. I am the Fiscal Year 1980 Chairman of the Hydrology Committee of the Water Resources Council. Lastly, I was the Office of Nuclear Reactor Regulation representative on the Nuclear Regulatory Commission Waste Management Review Group, an advisory group charged with reviewing agency programming in waste management. I have also participated on a number of task forces related to siting, the licensing process and contracting practices.

From March 1980 through mid-April 1981 I was employed in private industry as a Vice President with Tetra Tech, Inc. in Pasadena, California. During this period I was responsible for business development, and for managing several contracts involving various engineering studies in water, including several contracts for government and industry. Of note were studies of a nuclear power plant in Yugoslavia for the International Atomic Energy Agency, flood protection in the Dominican Republic, a refinery intake in Indonesia, and hurricane risk assessments in Texas, North Carolina, Florida, and New Jersey.

From 1968 to 1971, I was a Hydraulic Engineer with the Corps of Engineers' Hydrologic Engineering Center in Davis, California. I worked in special hydrologic engineering projects with most Corps' offices, participated as an instructor in training courses, and conducted research. Special projects work included water supply systems analysis for the Panama Canal, planning hydrologic engineering studies for water resource development near Fairbanks, Alaska, regional water supply and flood control studies for the northeastern U.S., design hydropower and water supply studies for a dam in the northeast, and flood control studies in Mississippi.

From 1963 to 1968, I was a Supervisory Hydraulic Engineer with the Philadelphia District, Corps of Engineers. As Assistant Chief of the Hydraulics Branch, I was responsible for hydrologic and hydraulic design of multi-purpose dams, navigation projects, coastal engineering development and special studies on hydraulic modeling of dams, inlets, water supply, and shoaling, salt water intrusion, and the hydraulic effects of dredging. I acted as advisor to the District Engineer, Philadelphia, on drought problems in the 1960's and represented him in technical meetings of the Delaware River Basin Commission - chaired interagency committee which evaluated the effects of the drought.

From 1958 to 1963, I was a Hydraulic Engineer with the Omaha District of the Corps of Engineers. I was responsible for the hydraulic design of flood control channels, hydraulic design of structures for large dams and several flood control projects. I also received training in hydrologic engineering, structural engineering, sedimentation, river training studies and design, and water resource project formulation.

I have published in journals of the American Society of Civil Engineers, the American Water Works Association, the Journal of Marine Geodesy, the National Society of Professional Engineers, the American Geophysical Union, and in internal technical papers and seminar proceedings of the Corps of Engineers.

I am a registered Professional Engineer in the States of Nebraska and California. I am a member of the American Society of Civil Engineers, the American Meteorological Society, and the American Geophysical Union.

MILLARD L. WOHL

PROFESSIONAL QUALIFICATIONS

ACCIDENT EVALUATION BRANCH

DIVISION OF SYSTEMS INTEGRATION

I am employed as a nuclear engineer in the Accident Evaluation Branch, Division of Systems Integration, U. S. Nuclear Regulatory Commission, Washington, D. C. My duties are to conduct site and accident analyses and various other safety-related studies for nuclear power and non-power reactor facilities.

I attended Case Western Reserve University (formerly Case Institute of Technology) and received a B. S. degree in Physics in 1956. I received a M. S. degree in Physics from Indiana University in 1958. I did graduate work in Nuclear Engineering at Columbia University and Case Western Reserve University from 1962 through 1964. I was a teaching assistant in Physics at Indiana University from 1956 - 1958. I have taught physics and mathematics in the evening divisions of Baldwin-Wallace College, the Ohio State University and Cuyahoga Community College from 1958 - 1973.

In 1958, I joined the NASA Lewis Research Center in Cleveland, Ohio. My initial duties involved the writing of Monte Carlo computer codes for the determination of radiation shielding requirements and propellant heating for proposed nuclear-powered rocket designs. Other assignments involved methods development and shielding and nuclear safety analyses for numerous proposed mobile nuclear vehicle applications. Numerous technical publications evolved in the course of this work. Additionally, during the period 1958 - 1973, I had substantial research contract management responsibilities.

In 1973, I joined the General Atomic Company in La Jolla, California, as a nuclear engineer. At General Atomic I performed a variety of nuclear safety-related analyses for the High-Temperature Gas-Cooled Reactor (HTGR). These included the analysis of depressurization accidents and containment integrity studies, as well as computer code upgrading and modification.

In 1975, I joined the Accident Analysis Branch in the Division of Technical Review, U. S. Nuclear Regulatory Commission. My responsibilities involved site characteristic studies and accident analyses. Presently, my responsibilities in the Accident Evaluation Branch involve evaluation of the radiological consequences of accidents postulated in connection with safety evaluations for operating reactors, and preparation of accident risk sections of Environmental Statements.

Professional Qualifications

Scott F. Newberry

Reliability and Risk Assessment Branch
Division of Safety Technology
U.S. Nuclear Regulatory Commission

My name is Scott F. Newberry. I am employed as a Risk Analyst in the Reliability and Risk Assessment Branch, Division of Safety Technology, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C.

I attended the United States Naval Academy, Annapolis, Maryland, and received a B.S. degree in 1970. I received a Masters degree in Mechanical Engineering from the Catholic University of America in Washington, D.C. in 1980.

From 1970 to 1971 I attended the Navy Nuclear Power Training Program which consisted of training at the Nuclear Power Training School, Bainbridge, Maryland, and the S3G submarine reactor prototype in West Milton, New York.

From 1972 until 1974 I worked as Engineering Officer of the Watch aboard the USS Daniel Boone SSBN 629 (Blue), a nuclear fleet ballistic missile submarine. My primary assignment was to serve as the ship's Main Propulsion Assistant and Radiological Controls Officer during this period. I was responsible for the ship's reactor coolant system and steam system propulsion machinery and the control of all radioactive material on board.

In 1974 I qualified as Nuclear Engineering Officer in the Naval Reactors Program.

From 1974 to 1976 I served as Weapons Officer, USS Nathan Hale SSBN 623 (GOLD). During this period I was involved in the ship's precritical and power range testing program during the nuclear refueling overhaul as a Command Duty Officer.

In December 1976, I started working for the Reactor Systems Branch, Division of Systems Safety, U.S. Nuclear Regulatory Commission, as a reactor engineer. I have reviewed construction and operating license safety analyses in the reactor systems areas for compliance with NRC regulations. The reactor systems areas included:

1. Structures, systems, and components to be protected from internally generated missiles inside containments.

2. Overpressure protection systems and the steam generator safety valves.

3. Reactor coolant pressure boundary leakage detection systems.

4. Residual heat removal systems.

5. Reactivity control systems.

6. Emergency core cooling systems.

7. Configuration and process design parameters of the reactor coolant pumps, steam generators (PWR); reactor coolant piping.

In 1979 I joined the Three Mile Island Program Office. My responsibilities included:

1. Analysis of plant conditions and proposed changes in system design or operation mode.

2. Review of proposed operating plans and system modifications, and procedures to accomplish major operations such as long-term cooling.

3. Preparation of Technical Specifications appropriate to the plant conditions and activities.

In October 1981 I joined the Reliability and Risk Assessment Branch. My responsibilities include performance of reliability and risk assessment reviews pertaining to the functional capability of nuclear power plant safety systems, equipment and procedures needed for safe plant operation and shutdown.

EDWARD F. BRANAGAN, JR.
OFFICE OF NUCLEAR REACTOR REGULATION

PROFESSIONAL QUALIFICATIONS

From April 1979 to the present, I have been employed in the Radiological Assessment Branch in the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission (NRC). As a Health Physicist with the Radiological Assessment Branch, I am responsible for evaluating the environmental radiological impacts resulting from the operation of nuclear power reactors. In particular, I am responsible for evaluating radioecological models and health effect models for use in reactor licensing.

In addition to my duties involving the evaluation of radiological impacts from nuclear reactors, my duties in the Radiological Assessment Branch have included the following: (1) I managed and was the principal author of a report entitled "Staff Review of 'Radioecological Assessment of the Wyhl Nuclear Power Plant'" (NUREG-0668); (2) I served as a technical contact on an NRC contract with Argonne National Laboratory involving development of a computer program to calculate health effects from radiation; (3) I served as the project manager on an NRC contract with Idaho National Engineering Laboratory involving estimated and measured concentrations of radionuclides in the environment; (4) I served as the project manager on an NRC contract with Lawrence Livermore Laboratory concerning a literature review of values for parameters in terrestrial radionuclide transport models; and (5) I served as the project manager on an NRC contract with Oak Ridge National Laboratory concerning a statistical analysis of dose estimates via food pathways.

From 1976 to April 1979, I was employed by the NRC's Office of Nuclear Materials Safety and Safeguards, where I was involved in project management and technical work. I served as the project manager for the NRC in connection with the NRC's estimation of radiation doses from radon-222 and radium-226 releases from uranium mills, in coordination with Oak Ridge National Laboratory which served as the NRC contractor. As part of my work on NRC's Generic Environmental Impact Statement on Uranium Milling (GEIS), I estimated health effects from uranium mill tailings. Upon publication of the GEIS, I presented a paper entitled "Health Effects of Uranium Mining and Milling for Commercial Nuclear Power" at a Conference on Health Implications of New Energy Technologies.

I received a B.A. in Physics from Catholic University in 1969, a M.A. in Science Teaching from Catholic University in 1970, and a Ph.D. in Radiation Biophysics from Kansas University in 1976. While completing my course work for my Ph.D., I was an instructor of Radiation Technology at Haskell Junior College in Lawrence, Kansas. My doctoral research work was in the area of DNA base damage, and was supported by a U.S. Public Health Service traineeship; my doctoral dissertation was entitled "Nuclear Magnetic Resonance Spectroscopy of Gamma-Irradiated DNA Bases."

I am a member of the Health Physics Society.

Attachment A

LEAGUE CONTENTION 8

Neither C.E. nor the Staff has presented a meaningful assessment of the risks associated with the operation of the proposed Byron nuclear facility, contrary to the requirements of 10 C.F.R. § 51.20(a) and § 51.20(d). Studies carried out by the NRC have identified accident mechanisms, considered credible, which would lead to uncontrolable accidents and release to the environment of appreciable fractions of a reactor's inventory of radioactive materials. Traditionally, these accident potentials have been downplayed or ignored on the basis of the Rasmussen Report. However, the Lewis Committee has now called into serious question the entire methodology, as well as the findings and conclusions, of the Rasmussen Report, which led the NRC to withdraw official reliance on the Rasmussen Report, yet the Staff still regulates upon the validity of the basic conclusions therein. In addition, NRC Staff studies, which are not common public knowledge, have cast doubt upon numberous of the specific conclusions of the Rasmussen Report. For example, in one secret NRC study, estimates of the "killing distance" were made, referring to the range over which lethal injuries would be received under varying weather conditions from the release of radioactive material in a nuclear power plant accident. Depending upon prevailing weather conditions, this "killing distance" was estimated to be up to several dozen miles from the accident-damaged reactor. Unpublished document from Brookhaven National Laboratory, USAEC. In addition, the Liquid Pathways Study, NUREG-0440 (February, 1978), highlights the incomplete safety assessment currently performed by the NRC, particularly with respect to incomplete review of all credible accident sequences. A General Accounting Office report pertaining to that study criticizes the NRC's failure to consider core-melt accidents in assessments of relative differences in Class 9 risks. The March 7, 1978 letter from the NRC's Mr. Case to the Commissioners (Secy-78-137) also urges the inclusion of core-melt considerations in site comparisons in the case of sites involving high population density, such as Byron and the surrounding area in which live now (or at time of proposed operation) upwards of 500,000 persons. Moreover, neither C.E. nor the NRC Staff has presented an accurate assessment of the risks posed by operation of Byron, contrary to the requirements of 10 C.F.R. § 51.20(a) and § 51.20(d). The decision to issue the Byron construction permit did not, and the presently filed analysis of C.E. and the Staff do not, consider the consequences of so-called Class 9 accidents, particularly core meltdown with breach of containment. These accidents were deemed to have a low probability of occurrence. The Reactor Safety Study, WASH-1400, was an attempt to demonstrate that the actual risk from Class 9 accidents is very low. However, the Commission has stated that it "does not regard as reliable the Reactor Safety Study's numerical estimate of the overall risk of reactor accident." (NRC Statement of Risk Assessment and the Reactor Safety Study Report (WASH-1400) in Light of the Risk Assessment Review Group Report, January 18, 1970). The withdrawal of NRC's endorsement of

the Reactor Sfaety Study and its findings leaves no technical basis for concluding that the actual risk is low enough to justify operation of Byron.

LEAGUE CONTENTION 62

The design of Byron does not provide protection against so-called "Class 9" accidents. There is no basis for concluding that such accidents are not credible. Indeed, the staff has conceded that the accident at TMI falls within that classification. Therefore, there is no reasonable assurance that Byron can be operated without endangering the health and safety of the public. See also Contention 8, supra."

DARRE/SAFE CONTENTION 2A

"Due to the concentration of nuclear power plants already in Northern Illinois; the Applicant's record of incidents and violations in existing plants which have emerged since the granting of a Construction License for Byron; and the credibility which must now be given to large scale accident scenarios since TMI, Intervenors contend that the addition of Byron Station operations places an undue and unfair burden of risk from exposure to radioactive materials from accidental releases on DeKalb-Sycamore and Rockford area residents. With the addition of two more nuclear power units in operation at Byron, the potential for cumulative dose effects from discrete accident events at plants in Northern Illinois under unfavorable meteorological conditions poses an unreasonable level of risk to the health and safety of DeKalb-Sycamore and Rockford area residents."

precise condition of the reactor core is not known at this time and cannot be known until the containment has been entered and the reactor vessel has been opened. For this reason, it is unrealistic to expect that the programmatic impact statement will serve as a blueprint, detailing each and every step to be taken over the coming months and years with their likely impacts. That the planned programmatic statement inevitably will have gaps and will not be a complete guide for all future actions does not invalidate its usefulness as a planning tool. As more information becomes available it will be incorporated into the decision-making process, and where appropriate supplements to the programmatic environmental impact statement will be issued. As the decontamination of TMI-2 progresses the Commission will make any new information available to the public and to the extent necessary will also prepare separate environmental statements or assessments for individual portions of the overall clean-up effort.

The development of a programmatic impact statement will not preclude prompt Commission action when needed. The Commission does recognize, however, that as with its Epicor-II approval action, any action taken in the absence of an overall impact statement will lead to arguments that there has been an inadequate environmental analysis, even where the Commission's action itself is supported by an environmental assessment. As in settling upon the scope of the programmatic impact statement, CEQ can lend assistance here. For example should the Commission before completing its programmatic statement decide that it is in the best interest of the public health and safety to decontaminate the high level waste water now in the containment building, or to purge that building of its radioactive gases, the Commission will consider CEQ's advice as to the Commission's NEPA responsibilities. Moreover, as stated in the Commission's May 25 statement, any action of this kind will not be taken until it has undergone an environmental review, and furthermore with opportunity for public comment provided.

However, consistent with our May 25 Statement, we recognize that there may be emergency situations, not now foreseen, which should they occur would require rapid action. To the extent practicable the Commission will consult with CEQ in these situations as well.

With the help of the public's comments on our proposals we intend to assure, pursuant to NEPA and the Atomic Energy Act, that the clean-up of TMI-2 is done consistently with the public health and safety, and with awareness of the choices ahead. We are directing our staff to include in the programmatic environmental impact statement on the decontamination and disposal of TMI-2 wastes an overall description of the planned activities and a schedule for their completion along with a discussion of alternatives considered and the rationale for choices made. We are also directing our staff to keep us advised of their progress in these matters.

45 FR 2893
Published 1/15/80

EPA Policy Statement; Planning Basis for Emergency Responses to Nuclear Power Reactor Accidents

Purpose

This is a statement of policy with regard to an Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) task force report on guidance for use in State and local radiological emergency response plans at nuclear power plants.

Background

The NRC received a request from the Conference of Radiation Control Program Directors, an organization of State officials, to "make a determination of the most severe accident basis for which radiological emergency response plans should be developed by offsite agencies." In response, an EPA and NRC task force was established which prepared a report entitled "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," NUREG-0396, EPA 520/1-78-016, dated December 1978. Single copies of the report can be obtained by writing to the Director, Division of Technical Information and Document Control, Nuclear Regulatory Commission, Washington, D.C. 20555.

Planning Basis

The major recommendation of the report is that Emergency Planning Zones (EPZ's) should be established around light water nuclear power plants. The EPZ for airborne exposure has a radius of about 10 miles; the EPZ for contaminated food has a radius of about 50 miles. Predetermined protective action plans are needed for the EPZ's. The exact size and shape of each EPZ will be decided by emergency planning officials after they consider the specific conditions at each site.

The report indicates that officials may have from one-half hour to several hours warning in which to implement protective actions before a release of radioactivity to the atmosphere.

The chemical and physical characteristics of those radionuclides which contribute most significantly to human exposure are presented.

EPA Policy

EPA concurs in and endorses for use the guidance contained in the task force report. It will be EPA's policy to incorporate its recommendations into all EPA emergency response guidance to State and local officials.

45 FR 40101
Published 6/13/80
Comment period expires 9/11/80

10 CFR Parts 50 and 51

Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969

AGENCY: U.S Nuclear Regulatory Commission

ACTION: Statement of Interim Policy.

SUMMARY: The Nuclear Regulatory Commission (NRC) is revising its policy for considering the more severe kinds of very low probability accidents that are physically possible in environmental impact assessments required by the National Environmental Policy Act (NEPA). Such accidents are commonly referred to as Class 9 accidents, following an accident classification scheme proposed by the Atomic Energy Commission (predecessor to NRC) in 1971 for purposes of implementing NEPA.[1] The March 28, 1979 accident at Unit 2 of the Three Mile Island nuclear plant has emphasized the need for changes in NRC policies regarding the considerations to be given to serious accidents from an environmental as well as a safety point of view.

This statement of interim policy announces the withdrawal of the proposed Annex to Appendix D of 10 CFR Part 50 and the suspension of the rulemaking proceeding that began with the publication of that proposed Annex on December 1, 1971. It is the Commission's position that its Environmental Impact Statements shall include considerations of the site-specific environmental impacts attributable to accident sequences that

[1] Proposed as an Annex to 10 CFR Part 50, Appendix D, 36 FR 22851. The Commission's NEPA-implementing regulations were subsequently (July 18, 1974) revised and recast as 10 CFR Part 51 but at that time the Commission noted that "The Proposed Annex is still under consideration * * *" 39 FR 26279.

Public Document Room.

Persons with questions may call Dr. Harry J. Watters in the Office of Management and Program Analysis, telephone 301–492–7721.

Written comments or questions should be addressed to the Director, Office of Management and Program Analysis, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Comments must be received by December 10, 1979.

44 FR 61123
Published 10/23/79

Planning Basis for Emergency Responses to Nuclear Power Reactor Accidents

AGENCY: Nuclear Regulatory Commission.

ACTION: NRC Policy Statement.

Purpose

This is a statement of policy with regard to an Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC) task force report on guidance for use in state and local radiological emergency response plans at nuclear power plants.

Background

The NRC received a request from the Conference of Radiation Control Program Directors, an organization of State officials, to "make a determination of the most servere accident basis for which radiological emergency response plans should be developed by offsite agencies." In response, an EPA and NRC task force was established which prepared a report entitled "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," NUREG–0396, EPA 520/1–78–016, dated December 1978. Single copies of the report can be obtained by writing to the Director, Division of Technical Information and Document Control, Nuclear Regulatory Commission, Washington, D.C. 20555. The task force report was published for public comment in the Federal Register on December 15, 1978 and the comment period was extended to May 15, 1979 to allow additional comments resulting from the accident at Three Mile Island. A synopsis of the comments received and the task force consideration of these comments is available from the Assistant Director for Emergency Preparedness, Office of State Programs, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Planning Basis

The major recommendation of the report is that two Emergency Planning Zones (EPZs) should be established around light water nuclear power plants. The EPZ for airborne exposure has a radius of about 10 miles; the EPZ for contaminated food has a radius of about 50 miles. Predetermined protective action plans are needed for the EPZs. The exact size and shape of each EPZ will be decided by emergency planning officials after they consider the specific conditions at each site. These distances are considered large enough to provide a response base which would support activity outside the planning zone should this ever be needed.

The report also provides planning basis guidance in the form of a range of time values in which emergency response officials should be prepared to implement protective action. The report indicates that, depending on such factors as the specific sequence of events during an accident which results in the release of radioactivity to the atmoshpere and the prevailing meteorological conditions, protective action may be required from perhaps one-half hour to one day after the intiation of the accident. Development and periodic testing of procedures for rapid notification of emergency response officials is encouraged, since the time available for action is strongly affected by the time consumed in notification.

The chemical and physical characteristics of those radionuclides which contribute most significantly to human exposure are presented.

NRC Policy

NRC concurs in and endorses for use the guidance contained in the task force report. In endorsing this guidance, the Commission recognizes that it is appropriate and prudent for emergency planning guidance to take into consideration the principal characteristics (such as nuclides released and distances likely to be involved) of a spectrum of design basis and core melt accidents. While the Commission recognizes that the guidance may have significant response impacts for many local jurisdictions, it believes that implementation of the guidance is nevetheless needed to improve emergency response planning and preparedness around nuclear power reactors.

The Commission is direction it's staff to incorporate the planning basis guidance into existing documents used in the evaluation of state an local emergency response plans to the extent practicable. The NRC has recently published and Advance Notice of Proposed Rulemaking concerning additional regulations on emergency plans, 44 FR 41484, Tuesday, July 17, 1979. Additional guidance will be provided following this rulemaking. This additional guidance can be expected to consider how local conditions such as demography, land use, and meteorology can influence the size an shape of the EPZs and to address other issues, such as evacuation planning.

Specific implementation dates for full implementation of the task force recommendations and any others that are developed will be established as part of the ongoing rulemaking effort. The Commission also expects the staff to assist state and local governments in improving their emergency response capabilities at existing sites in the immediate future.

44 FR 67738
Published 11/27/79

Statement of Policy and Notice of Intent To Prepare a Programmatic Environmental Impact Statement

AGENCY: U.S. Nuclear Regulatory Commission.

ACTION: Statement of Policy.

SUMMARY: The Nuclear Regulatory Commission has decided to prepare a programmatic environmental impact statement on the decontamination and disposal of radioactive wastes resulting from the March 28, 1979 accident at Three Mile Island Unit 2. For some time the Commission's staff has been moving in this direction. In the Commission's judgment an overall study of the decontamination and disposal process will assist the Commission in carrying out its regulatory responsibilities under the Atomic Energy Act to protect the public health and safety as decontamination progresses. It will also be in keeping with the purposes of the National Environmental Policy Act to engage the public in the Commission's decision-making process, and to focus on environmental issues and alternatives before commitments to specific clean-up choices are made. Additionally, in light of the extraordinary nature of this action and the expressed interest of the President's Council on Environmental Quality in the TMI–2 clean-up, the Commission intends to co-ordinate its action with CEQ. In particular, before determining the scope of the programmatic environmental impact statement the Commission will consult with CEQ.

The Commission recognizes that there are still areas of uncertainty regarding the clean-up operation. For example, the

lead to releases of radiation and/or radioactive materials, including sequences that can result in inadequate cooling of reactor fuel and to melting of the reactor core. In this regard, attention shall be given both to the probability of occurrence of such releases and to the environmental consequences of such releases. This statement of interim policy is taken in coordination with other ongoing safety-related activities that are directly related to accident considerations in the areas of plant design, operational safety, siting policy, and emergency planning. The Commission intends to continue the rulemaking on this matter when new siting requirements and other safety related requirements incorporating accident considerations are in place.

DATES: This statement of interim policy is effective June 13, 1980 Comment period expires September 11, 1980.

ADDRESSES: The Commission intends the interim policy guidance contained herein to be immediately effective. However, all interested persons who desire to submit written comments or suggestions for consideration in connection with this statement should send them to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch.

FOR FURTHER INFORMATION CONTACT: R. Wayne Houston, Chief, Accident Evaluation Branch Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Telephone: (301) 492-7323.

SUPPLEMENTAPY INFORMATION:

Accident Considerations in Past NEPA Reviews

The proposed Annex to Appendix D of 10 CFR Part 50 (hereafter the "Annex") was published for comment on December 1, 1971 by the (former) Atomic Energy Commission. It proposed to specify a set of standardized accident assumptions to be used in Environmental Reports submitted by applicants for construction permits or operating licenses for nuclear power reactors. It also included a system for classifying accidents according to a graded scale of severity and probability of occurrence. Nine classes of accidents were defined, ranging from trivial to very serious. It directed that "for each class, except classes 1 and 9, the environmental consequences shall be evaluated as indicated." Class 1 events were not to be considered because of their trivial consequences, whereas in regard to Class 9 events, the Annex stated as follows:

> The occurrences in Class 9 involve sequences of postulated successive failures more severe than those postulated for the design basis for protective systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently remote in probability that the environmental risk is extremely low. For these reasons, it is not necessary to discuss such events in applicants' Environmental Reports.

A footnote to the Annex stated:

> Although this annex refers to applicant's Environmental Reports, the current assumptions and other provisions thereof are applicable, except as the content may otherwise require, to AEC draft and final Detailed Statements.

During the public comment period that followed publication of the Annex a number of criticisms of the Annex were received. Principal among these were the following:

(1) The philosophy of prescribing assumptions does not lead to objective analysis.

(2) It failed to treat the probabilities of accidents in any but the most general way.

(3) No supporting analysis was given to show that Class 9 accidents are sufficiently low in probability that their consequences in terms of environmental risks need not be discussed.

(4) No guidance was given as to how accident and normal releases of radioactive effluents during plant operation should be factored into the cost-benefit analysis.

(5) The accident assumptions are not generally applicable to gas cooled or liquid metal cooled reactors.

(6) Safety and environmental risks are not essentially different considerations.

Neither the Atomic Energy Commission nor the NRC took any further action on this rulemaking except in 1974 when 10 CFR Part 51 was promulgated. Over the intervening years the accident considerations discussed in Environmental Impact Statements for proposed nuclear power plants reflected the guidance of the Annex with few exceptions. Typically, the discussions of accident consequences through Class 8 (design basis accidents) for each case have reflected specific site characteristics associated with meteorology (the dispersion of releases of radioactive material into the atmosphere), the actual population within a 50-mile radius of the plant, and some differences between boiling water reactors (BWR) and pressurized water reactors (PWR). Beyond these few specifics, the discussions have reiterated the guidance of the Annex and have relied upon the Annex's conclusion that the probability of occurrence of a Class 9 event is too low to warrant consideration, a conclusion based upon generally stated safety considerations.

With the publication of the Reactor Safety Study (WASH-1400), in draft form in August 1974 and final form in October 1975, the accident discussions in Environmental Impact Statements began to refer to this first detailed study of the risks associated with nuclear power plant accidents, particularly events which can lead to the melting of the fuel inside a reactor.[2] The references to this study were in keeping with the intent and spirit of NEPA "to disclose" relevant information, but it is obvious that WASH-1400 did not form the basis for the conclusion expressed in the Annex in 1971 that the probability of occurrence of Class 9 events was too low to warrant their (site-specific) consideration under NEPA.

The Commission's staff has, however, identified in certain cases unique circumstances which it felt warranted more extensive and detailed consideration of Class 9 events. One of these was the proposed Clinch River Breeder Reactor Plant (CRBRP), a liquid metal cooled fast breeder reactor very different from the more conventional light water reactor plants for which the safety experience base is much broader. In the Final Environmental Statement for the CRBRP,[3] the staff included a discussion of the consideration it had given to Class 9 events.

In the early site review for the Perryman site, the staff performed an informal assessment of the relative differences in Class 9 accident consequences among the alternative sites. (SECY-78-137)

In the case of the application by Offshore Power Systems to manufacture floating nuclear power plants, the staff judged that the environmental risks of some Class 9 events warranted special consideration. The special circumstances were the potentially serious consequences associated with water (liquid) pathways leading to radiological exposures if a molten reactor core were to fall into the water

[2] It is of interest that the Reactor Safety Study never refers to nor uses the term "Class 9 accident" although this term is commonly used as loosely equivalent to a core melt accident.

[3] NUREG-0139, February 1977.

body on which the plant floats. Here the staff emphasized its focus on risk to the environment but did not find that the probability of a core melt event occurring in the first place was essentially any different than for land-based plant. In its Memorandum and Order In the Matter of Offshore Power Systems,[4] the Commission consurred in the staff's judgment. Thus, the Reactor Safety Study and NRC experience with these cases has served to refocus attention on the need to reemphasize that environmental risk entails both probabilities and consequences, a point that was made in the publication of the Annex, but was not given adequate emphasis.

In July 1977 the NRC commissioned a Risk Assessment Review Group "to clarify the achievements and limitations of the Reactor Safety Study." One of the conclusions of this study, published in September 1978, as NUREG/CR-0400, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," was that "The Review Group was unable to determine whether the absolute probabilities of accident sequences in WASH-1400 are high or low, but believes that the error bounds on those estimates are in general, greatly understated." This and other findings of the Review Group have also subsequently been referred to in Environmental Impact Statements, along with a reference to the Commission's policy statement on the Reactor Safety Study in light of the Risk Assessment Review Group Report, published on January 18, 1979. The Commission's statement accepted the findings of the Review Group, both as to the Reactor Safety Study's achievements and as to its limitations.

A few Draft Environmental Statements have been published subsequent to the Three Mile Island accident. These were for conventional land-based light water reactor plants and continued to reflect the past practice with respect to accidents at such plants, but noted that the experience gained from the Three Mile Island accident was not factored into the discussion.

Our experience with past NEPA reviews of accidents and the TMI accident clearly leads us to believe that a change is needed.

Accordingly, the proposed Annex to Appendix D of 10 CFR Part 50, published on December 1, 1971, is hereby withdrawn and shall not hereafter be used by applicants nor by the staff. The reasons for the withdrawal are as follows:

1. The Annex proscribes consideration of the kinds of accidents (Class 9) that, according to the Reactor Safety Study, dominate the accident risk.

2. The definition of Class 9 accidents in the Annex is not sufficiently precise to warrant its further use in Commission policy, rules, and regulations, nor as a decision criterion in agency practice.

3. The Annex's prescription of assumptions to be used in the analysis of the environmental consequences of accidents does not contribute to objective consideration.

4. The Annex does not give adequate consideration to the detailed treatment of measures taken to prevent and to mitigate the consequences of accidents in the safety review of each application.

The classification of accidents proposed in that Annex shall no longer be used. In its place the following interim guidance is given for the treatment of accident risk considerations in NEPA reviews.

Accident Considerations in Future NEPA Reviews

It is the position of the Commission that its Environmental Impact Statements, pursuant to Section 102(c)(i) of the National Environmental Policy Act of 1969, shall include a reasoned consideration of the environmental risks (impacts) attributable to accidents at the particular facility or facilities within the scope of each such statement. In the analysis and discussion of such risks, approximately equal attention shall be given to the probability of occurrence of releases and to the probability of occurrence of the environmental consequences of those releases. Releases refer to radiation and/or radioactive materials entering environmental exposure pathways, including air, water, and ground water.

Events or accident sequences that lead to releases shall include but not be limited to those that can reasonably be expected to occur. In-plant accident sequences that can lead to a spectrum of releases shall be discussed and shall include sequences that can result in inadequate cooling of reactor fuel and to melting of the reactor core. The extent to which events arising from causes external to the plant which are considered possible contributors to the risk associated with the particular plant shall also be discussed. Detailed quantitative considerations that form the basis of probabilistic estimates of releases need not be incorporated in the Environmental Impact Statements but shall be referenced therein. Such references shall include, as applicable, reports on safety evaluations.

The environmental consequences of releases whose probability of occurence has been estimated shall also be discussed in probabilistic terms. Such consequences shall be characterized in terms of potential radiological exposures to individuals, to population groups, and, where applicable, to biota. Health and safety risks that may be associated with exposures to people shall be discussed in a manner that fairly reflects the current state of knowledge regarding such risks. Socioeconomic impacts that might be associated with emergency measures during or following an accident should also be discussed. The environmental risk of accidents should also be compared to and contrasted with radiological risks associated with normal and anticipated operational releases.

In promulgating this interim guidance, the Commission is aware that there are and will likely remain for some time to come many uncertainties in the application of risk assessment methods, and it expects that its Environmental Impact Statements will identify major uncertainties in its probabilistic estimates. On the other hand the Commission believes that the state of the art is sufficiently advanced that a beginning should now be made in the use of these methodologies in the regulatory process, and that such use will represent a contructive and rational forward step in the discharge of its reponsibilities.

It is the intent of the Commission in issuing this Statement of Interim Policy that the staff will initiate treatments of accident considerations, in accordance with the foregoing guidance, in its ongoing NEPA reviews, i.e., for any proceeding at a licensing stage where a Final Environmental Impact Statement has not yet been issued. These new treatments, which will take into account significant site- and plant-specific features, will result in more detailed discussions of accident risks than in previous environmental statements, particularly for those related to conventional light water plants at land-based sites. It is expected that these revised treatments will lead to conclusions regarding the environmental risks of accidents similar to those that would be reached by a continuation of current practices, particularly for cases involving special circumstances where Class 9 risks have been considered by the staff, as described above. Thus, this change in policy is not to be construed as any lack of confidence in conclusions regarding the environmental risks of accidents expressed in any previously

[4] Docket No. STN 50-437, September 14, 1979.

issued Statements, nor, absent a showing of similar special circumstances, as a basis for opening, reopening, or expanding any previous or ongoing proceeding.[5]

However, it is also the intent of the Commission that the staff take steps to identify additional cases that might warrant early consideration of either additional features or other actions which would prevent or mitigate the consequences of serious accidents. Cases for such consideration are those for which a Final Environmental Statement has already been issued at the Construction Permit stage but for which the Operating License review stage has not yet been reached. In carrying out this directive, the staff should consider relevant site features, including population density, associated with accident risk in comparison to such features at presently operating plants. Staff should also consider the likelihood that substantive changes in plant design features which may compensate further for adverse site features may be more easily incorporated in plants when construction has not yet progressed very far.

Environmental Reports submitted by applicants for construction permits and for operating licenses on or after July 1, 1980 should include a discussion of the environmental risks associated with accidents that follows the guidance given herein.

Related Policy Matters Under Consideration

In addition to its responsibilities under NEPA, the NRC also bears responsibility under the Atomic Energy Act for the protection of the public health and safety from the hazards associated with the use of nuclear energy. Pursuant to this responsibility the Commission notes that there are currently a number of ongoing activities being considered by the Commission and its staff which intimately relate to the "Class 9 accident" question and which are either the subject of current rulemaking or are candidate subjects for rulemaking.

On December 19, 1979 the Commission issued for public comment[6] a proposed rule which would significantly revise its requirements in 10 CFR Part 50 for emergency planning for nuclear power plants. One of the considerations in this rulemaking was the potential consequences of Class 9 accidents in a generic sense.[7]

In August 1979, pursuant to the Commission's request, a Siting Policy Task Force made recommendations with respect to possible changes in NRC reactor siting policy and criteria,[8] currently set forth in 10 CFR Part 100. As stated therein, its recommendations were made to accomplish (among others) the following goal:

> To take into consideration in siting the risk associated with accidents beyond the design basis (Class 9) by establishing population density and distribution criteria.

This matter is currently before the Commission.

This and other recommendations that have been made as a result of the investigations into the Three Mile Island accident are currently being brought together by the Commission's staff in the form of proposed Action Plans.[9] Among other matters, these incorporate recommendations for rulemaking related to degraded core cooling and core melt accidents. The Commission expects to issue decisions on these Action Plans in the near future. It is the Commission's policy and intent to devote NRC's major resources to matters which the Commission believes will make existing and future nuclear power plants safer, and to prevent a recurrence of the kind of accident that occurred at Three Mile Island. In the interim, however, and pending completion of rulemaking activities in the areas of emergency planning, siting criteria, and design and operational safety, all of which involve considerations of serious accident potential, the Commission finds it essential to improve its procedures for describing and disclosing to the public the basis for arriving at conclusions regarding the environmental risks due to accidents at nuclear power plants. On completion of the rulemaking activities in these areas, and based also upon the experience gained with this statement of interim policy and guidance, the Commission intends to pursue possible changes or additions to 10 CFR Part 51 to codify its position on the role of accident risks under NEPA.

[5] Commissioners Gilinsky and Bradford disagree with the inclusion of the preceding two sentences. They feel that they are absolutely inconsistent with an even-handed reappraisal of the former, erroneous position on Class 9 accidents.

[6] 44 FR 75167.

[7] Cf. NUREG-0396, "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," November 1978.

[8] NUREG-0625, "Report of the Siting Policy Task Force," August 1979.

[9] Draft NUREG-0660, "Action Plans for Implementing Recommendations of the President's Commission and Other Studies of the TMI-2 Accident," December 10, 1979.

45 FR 41738
Published 6/20/80

Further Commission Guidance for Power Reactor Operating Licenses; Statement of Policy[1]

I. Background

After the March 1979 accident at Three Mile Island, Unit 2, the Commission directed its technical review resources to assuring the safety of operating power reactors rather than to the issuance of new licenses. Furthermore, the Commission decided that power reactor licensing should not continue until the assessment of the TMI accident had been substantially completed and comprehensive improvements in both the operation and regulation of nuclear power plants had been set in motion.

At a meeting on May 30, 1979, the Nuclear Regulatory Commission decided to issue policy guidance addressing general principles for reaching licensing decisions and to provide specific guidance for near-term operating license cases.[2] In November 1979, the Nuclear Regulatory Commission issued the policy guidance in the form of an amendment to 10 CFR Part 2 of its regulations,[3] describing the approach to be taken by the Commission regarding licensing of power reactors. In particular, the Commission noted that it would "be providing case-by-case guidance on changes in regulatory policies." The Commission has now acted on three operating licenses, has given extensive consideration to issues arising as a result of the Three Mile Island accident, and is able to provide general guidance.

Following the accident at Three Mile Island 2, the President established a Commission to make recommendations regarding changes necessary to improve nuclear safety. In May 1979, the Nuclear Regulatory Commission established a Lessons Learned Task Force,[4] to determine what actions were required for new operating licenses and chartered a Special Inquiry Group to examine all facets of the accident and its causes. These groups have published

[1] All footnotes for this statement of policy appear at end of text.

[2] "Staff Requirements—Discussion of Options Regarding Deferral of Licenses," memorandum from Samuel J. Chilk, Secretary to Lee V. Gossick, Executive Director for Operations, May 31, 1979.

[3] "Suspension of 10 CFR 2.764 and Statement of Policy on Conduct of Adjudicatory Proceedings," 44 FR 65050 (November 8, 1979).

[4] "Lessons Learned from TMI-2 Accident," Roger Mattson to NRR staff, May 31, 1979.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

CHAIRMAN

December 27, 1982

The Honorable Morris K. Udall
Chairman, Committee on Interior
and Insular Affairs
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

Your letter to me dated October 1, 1982 cited Mr. Bender's recent comments concerning the use of probabilistic risk assessment (PRA) and asked for answers to three questions. Before responding to your questions, I would like to comment on the statements made in your letter.

I would first like to note that the section you have quoted from the January 18, 1979, Commission's statement on the use of risk assessment is substantially less than the Commission's response to the Lewis Committee Review. A few additional quotes will serve to amplify this. The Commission commented on the findings of the Lewis Report and said:

> "The Commission accepts these findings and takes the following actions:
>
> .....
>
> Accident Probabilities: The Commission accepts the Review Group Report's conclusion that absolute values of the risks presented by WASH 1400 should not be used uncritically either in the regulatory process or for public policy purposes and has taken and will continue to take steps to assure that any such use in the past will be corrected as appropriate. In particular, in light of the Review Group conclusions on accident probabilities, the Commission does not regard as reliable the Reactor Safety Study's numerical estimate of the overall risk of reactor accident.
>
> .....
>
> With respect to the component parts of the Study, the Commission expects the staff to make use of them as appropriate, that is, where the data base is adequate and analytical techniques permit. Taking due account of the reservations expressed in the Review Group Report and in its presentation to the Commission, the Commission supports the extended use of probabilistic risk assessment in regulatory decisionmaking."

The Commission also approved a directive which was sent from the Secretary of the Commission to the Executive Director for Operations on January 18, 1979. Some sections are particularly germane to answering your questions:

Attachment C

"Quantitative risk assessment techniques and results can be used in the licensing process if proper consideration is given to the results of the Review Group. The staff should use the following procedures regarding the use of quantitative risk assessment techniques and results pending development of further guidance:

....

Quantitative risk assessment techniques may be used to estimate the relative importance of potential nuclear power plant accident sequences or other features where sufficient similarity exists so that the comparisons are not invalidated by lack of an adequate data base.....

The quantitative estimates of event probabilities in the RSS should not be used as the principal basis for any regulatory decision. However, these estimates may be used for relative comparisons of alternative designs or requirements provided that explicit considerations are given to the criticisms of those estimates as set forth in the Report of the Risk Assessment Review Group.

The RSS consequence model shall not be used as the basis for licensing decisions regarding individual nuclear power plant sites until significant refinements and sensitivity tests are accomplished. However, the consequence model may be used for relative comparisons provided that such estimates are not the primary basis for such reviews and provided that explicit consideration is given to the criticisms of the various elements of that model as set forth in the Report of the Risk Assessment Review Group."

The Commission went on in this memo to direct the staff to expand its use of probabilistic risk assessment:

"The staff shall give special attention to those activities identified by the Review Group as being especially amenable to risk assessment, i.e., dealing with generic safety issues, formulating new regulatory requirements, assessing and re-validating existing regulatory requirements, evaluating new designs, and formulating reactor safety research and inspection priorities."

Given the content of the Commission's statement on the Lewis Report and the directive to the Executive Director for Operations, the Commission believes that it holds essentially the same position on the use of PRA now as it had on January 18, 1979.

With regard to Mr. Bender's remarks appended to the September 15, 1982 ACRS letter, we agree with Mr. Bender that there are large uncertainties in the quantitative assessments of risk from nuclear power plant accidents. These uncertainties arise from several areas, including: (1) inadequacies

in the data base; (2) incomplete present knowledge of core melt phenomena, in-plant fission product transport, and containment performance; (3) the effect of unidentified systems interactions; (4) difficulties in quantitatively modeling human behavior; and (5) large uncertainties in the risk from external initiators. However, we believe that the data base is not as poor as implied by Mr. Bender; there are programs underway to develop a better understanding of core melt phenomena, containment performance, and fission product transport, and to improve the probabilistic assessment of external events.

Commissioner Gilinsky adds:

"My own views on the usefulness and the limitations of 'probabilistic risk assessment' and its use in the Reactor Safety Study are still pretty much as expressed in the (unanimously adopted) Commission statement of January 18, 1979. I am not at all in agreement with the current Commission's increasing tendency to view probabilistic risk assessment together with a quantitative 'safety goal' as a shortcut to regulatory decisionmaking. I am particularly concerned about resort to these calculational techniques in combination with sparse data to explain away the need for the traditional independent safety barriers which have been chosen on the basis of experience and engineering judgment. I have the impression that Mr. Bender and I are in philosophical agreement on these points. To cite one example that I find especially telling on the paucity of equipment reliability data, it was not until last year that full-scale tests were run on the large safety valves used to protect against excessive pressures in reactor coolant systems. And even these tests did not cover the full range of conditions to which such valves might be subject."

The majority of the Commissioners do not agree with his statement that the Commission is tending "to view probabilistic risk assessment together with a quantitative 'safety goal' as a shortcut to regulatory decisionmaking."*

Commissioner Asselstine adds:

"Since I did not participate in the development of the Commission's view on the usefulness of the PRA methodology as given in the January 18, 1979 statement, I defer to my colleagues as to whether there has been a change in that view since then. I do believe that, with this Commission's consideration of a safety goal containing quantitative benchmarks for judging an acceptable level of risk, there is necessarily a greater emphasis on the use of the PRA methodology than would otherwise exist. Because of the wide spectrum of expert views on the ability of the PRA methodology to provide reliable estimates of the risk associated with the operation of nuclear reactors, I believe the basis for safety must continue to depend on compliance with our regulations and on the judgment of responsible individuals. On the latter, judgment is aided significantly

through systematic reviews and careful analyses of available information. I believe the PRA methodology has a role to play here, provided that the Commission adheres to its view of January 18, 1979, and provided that the concerns expressed by Mr. Bender and others are properly accounted for."

I trust that this has been responsive to your concerns.

Sincerely,

Original Signed By
John F. Ahearne

John F. Ahearne
Acting

cc: Rep. Manuel Lujan

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MR. RAWSON: The witnesses are available for cross examination.

MR. THOMAS: Judge, I would indicate that the outline of the cross examination would be essentially the same as that of Dr. Levine, supplemented by some additional questions which I submit to the Board at this time. It will follow the same general parameters.

CROSS EXAMINATION BY COUNSEL FOR
INTERVENOR ROCKFORD LEAGUE OF WOMEN
VOTERS

BY MR. THOMAS:

Q I guess this question would be addressed to Mr. Wohl and Mr. Hulman. I forget who is who.

A (WITNESS HULMAN) I am Mr. Hulman.

Q Okay. On Page 2, Answer 3, you refer to the FES for Byron, specifically 5.9.4, and you indicate that it contains a recent consideration of environmental risks and that you adopt it as part of your testimony.

Does your testimony still stand in light of the letter from Mr. Tramm to Mr. Denton that's been referred to earlier in this proceeding? Are you familiar with that letter?

A (WITNESS HULMAN) Are you referring to the letter which transmitted the so-called mini-PRA?

Q No. I am referring to the letter which -- for --

MR. GALLO: May I?

MR. THOMAS: Do you have an extra copy? Thank you.

MR. GALLO: Okay.

MR. THOMAS: It's the letter dated March 11th --

JUDGE CALLIHAN: 1983.

MR. THOMAS: -- 1983.

Can I discusses higher transmissivity values than were previously calculated?

A (WITNESS HULMAN) I am familiar with the letter.

Would you please repeat your question?

MR. THOMAS: Certainly.

BY MR. THOMAS:

Q Does the fact that the transmissivity values should be of an order of magnitude higher, as indicated in the letter, and that the liquid pathway calculations are being recalculated, do you still stand by your testimony in Answer 3?

A (WITNESS HULMAN) I believe we stand by all our testimony except that portion of the FES which specifically addresses the liquid pathways, starting on Page 5-56, subparagraph pren 5 close pren, called, "releases to ground water."

Q All right.

A (WITNESS HULMAN) That is, everything having to do with

the atmospheric pathway we would stand by.

Q Okay. This section, releases to ground water, covers 5-56, 57,58, and approximately half of 59; is that right?

A (WITNESS HULMAN) That's correct.

Q Are you withdrawing that as part of your testimony, those pages I mentioned, or --

A (WITNESS HULMAN) No, sir. We are saying that the question of whether that particular section is still valid must await a re-assessment of the information provided by the Applicant.

Q All right.

A (WITNESS HULMAN) And we are not the Staff people that are responsible for that re-evaluation directly.

We only have the supervisory responsibility for seeing to it that that pathway is discussed and comparing the conclusions from the liquid pathway with the atmospheric pathway.

Q Okay. Isn't it true that the liquid pathway calculations are interrelated with other calculations in the FES?

A (WITNESS HULMAN) Yes.

Q And, therefore, a recalculation of the liquid pathway calculations is necessarily going to affect other portions of the FES; right?

A (WITNESS HULMAN) Not necessarily.

Q But there is that possibility?

A (WITNESS HULMAN) Yes.
Q Depending on what those recalculations turn out to be?
A (WITNESS HULMAN) That is correct.
Q So then there is a possibility that other portions of your or of the FES would be changed, depending upon the liquid pathway recalculations?
A (WITNESS HULMAN) My understanding is there would only be one other section that would be impacted.
Q What is that?
A (WITNESS HULMAN) That would be the possibility that the section called, "Risk Considerations, pren 6 close pren," starting on Page 5-59, might be affected; but that would be speculation.
Q Well, it's speculation either way at this point, isn't it?
A (WITNESS HULMAN) Possibly speculation. There has been some Staff experience with this subject matter, which would indicate that if history is any precedent for what is happening now with this subject, it's doubtful that the conclusions would change.
Q Now, when you say "risk considerations," are you referring to Pages 5-59 through 5-65 as being an area that would possibly change? Does that include the charts in there, also?
A (WITNESS HULMAN) That doe not include the charts, but it does include the possibility of the text being changed.

JUDGE SMITH: If this discussion is going to go on much, I think the Board ought to get their copies. We don't have it.

Would you recommend that?

MR. THOMAS: I would, I would; because I had planned to ask some questions based on the FES, so it would probably be --

JUDGE SMITH: It will just be a few minutes to get our copies.

MR. RAWSON: Judge Smith, we have additional copies if that turns out to be necessary.

JUDGE SMITH: Thanks.

(Recess.)

JUDGE SMITH: Would you give us a page reference?

MR. THOMAS: 5-59, Judge.

Actually, we have spoken of 5-56 through 5-59, which covers the ground water; and right now we were addressing the risk considerations that begin on 5-59 and go through 5-65, although the witness has indicated that the charts, the charts would not be affected, only the text possibly.

May I proceed?

JUDGE SMITH: Yes.

BY MR. THOMAS:

Q Can you state any parameters as to when changes in the

sections that you have indicated -- possible changes in the sections that you have indicated -- might be record?

A (WITNESS HULMAN) It depends on what the outcome of the Staff's assessment of what the Applicant has said with respect to the parameters he now wishes to change.

If the Staff assessment shows little or no difference in conclusions, there may be no need to alter the text.

If it shows significant conclusions, it may very well require some significant changes.

Q Are you able to indicate some parameters of the magnitude of recalculation which would result in changes, or is that beyond -- or is that impossible to predict?

Do you understand the question?

A (WITNESS HULMAN) Not really.

Would you restate it?

Q Yes.

Is it possible to -- well, strike that.

Is it possible for you to indicate which portions of risk considerations might change and which portions of the text might change and which would stand?

In other words, are there certain paragraphs that might be affected and others that would not?

A (WITNESS HULMAN) I think it would be easier if I were to attempt to characterize what might happen if the Staff

assessment of the liquid pathway were to indicate a significant change in conclusion with respect to risk.

Q Okay. What would happen in that event?

A (WITNESS HULMAN) The judgment of total risk would change. The FES is presently written with the conclusion that the atmospheric pathway dominates the risk.

If assessment of the liquid pathway indicates that it could also be significant, estimates of total risk could go up. However, I note that in virtually every case for which the liquid pathway has been considered, with one exception, to my knowledge, there has not been a single instance where liquid pathway risk considerations have been significant, including the kind of interdiction that we would normally anticipate.

Q What is the exception?

A (WITNESS HULMAN) The exception was the floating nuclear power plant for which the original subject of the liquid pathway was first investigated under generic and site specific manner, both ways, generic and site specific.

Since this reactor is not a floating plant, it doesn't apply.

Q All right. What do you mean when you say on Page 3, Question 5 and Answer 5, that external natural and man-caused events have been considered in preparing the FES only qualitatively?

A (WITNESS HULMAN) No numerical estimate of the risks from external events and sabotage have been quantified.

Q And why is that?

A (WITNESS HULMAN) It's generally considered beyond the state of the art.

Q Of quantification?

A (WITNESS HULMAN) Of good quantification.

Q What did the qualitative analysis of such problems as tornadoes, fires, earthquakes and sabotage consist of?

A (WITNESS HULMAN) What considerations?

Q No. What did the qualitative analysis consist of?

You say it's been considered qualitatively.

A (WITNESS HULMAN) It consisted, basically, of two considerations.

The first consideration was of the deterministic criteria that the Staff uses for design bases. Every single one of the possible external events -- and I am putting sabotage in that category -- is considered within the Staff's design criteria in a deterministic manner.

In addition to that, we have considered in a qualitative manner events beyond design basis.

We have little information, we have some. We attempted to characterize the risks from such events as being within the uncertainties that we have estimated for internal events.

Q What is the basis for that determination if you have so little information?
A (WITNESS HULMAN) Engineering judgment.
Q Whose engineering judgment, Staff's?
A (WITNESS HULMAN) Yes.
Q Did you make the engineering judgment or other people on Staff make the engineering judgment?
A (WITNESS HULMAN) It was a collective judgment. I was party to it.
Q Who else was involved?
A (WITNESS HULMAN) Mr. Wohl was involved and a couple of others on my Staff and my supervisor and other supervisors in the Agency.

It was done collectively.

Q Did this group, this collective group, review, for example, the seismic -- the testimony of Dr. Woodard on behalf of the League with regard to the seismic considerations?
A (WITNESS HULMAN) I --

MR. RAWSON: Objection. Judge, it's quite clear that that information was well after issuance of this document and I fail to see that an answer to this question is going to elicit time any permissible evidence.

JUDGE SMITH: It may be, but I don't see that as the basis for an objection. It may not be, you know, a

real winner of a question.

MR. RAWSON: I will withdraw it.

A (WITNESS HULMAN) Let's see if I understand your question. You had a witness speaking to seismic matters?

MR. THOMAS: Right.

A (WITNESS HULMAN) I am trying to remember whether any member of the group that participated in this assessment of external events was privy to that testimony; and I believe the answer is no but I am not certain.

BY MR. THOMAS:

Q Well, that includes exactly the question.

And I take it no member of the group was here when Dr. Woodard testified with regard to seismology?

A (WITNESS HULMAN) I believe that is correct.

Q With regard to sabotage, was any member of the group here during the testimony of Mr. Roulo on behalf of the Applicant regarding sabotage?

A (WITNESS HULMAN) My recollection is that one of the people consulted on these conclusions may have been privy to that testimony.

Q You mean the prefiled testimony or the testimony in at the hearing?

A (WITNESS HULMAN) May I consult with Mr. Wohl for a moment?

Q Sure.

A (WITNESS HULMAN) It's possible that the Staff did know of that testimony but I can't say for certain.

JUDGE SMITH: I think you have an ambiguous state of affairs here now.

MR. THOMAS: I do, too. I am going to go back.

BY MR. THOMAS:

Q By that were you referring to the prefiled testimony or the testimony before the Board or both?

A (WITNESS HULMAN) Both.

MR. THOMAS: Does that clear up the ambiguity that the Board was concerned with?

JUDGE SMITH: Yes, but it just replaces it with curiosity, how that came to pass.

Do you understand that Mr. Roulo testified here in camera in a confidential hearing and that --

A (WITNESS HULMAN) I understand that; but the extent to which that testimony and other testimony on sabotage in this case was considered by the individual consultant in coming to these conclusions is not clear in my mind. I simply don't know.

I can identify the individual on the Staff that was consulted.

JUDGE SMITH: You are talking about the corrections which have been made since the testimony was prepared?

A (WITNESS HULMAN) That is correct.
BY MR. THOMAS:
Q Oh, you are? You are talking about the Page 4 corrections now?
A (WITNESS HULMAN) Yes.
Q Well, let me get back to what I was asking.

I take it that you cannot testify here under oath that these matters weren't taken into consideration, is that right, because you --
A (WITNESS HULMAN) I don't know.
Q Right, all right. Isn't the qualitative analysis that was made of these external events deficient, at least to the extent that it fails to take into account testimony proffered on behalf of the Intervenor League?
A (WITNESS HULMAN) I do not believe that the qualitative testimony is deficient.
Q Why?
A (WITNESS HULMAN) Because what the qualitative testimony attempts to do is identify generically what the uncertainties are associated with such events; and I don't think that direct testimony on the subject is likely to shed much like numerically on such estimates.

It could very well shed light on qualitative judgments but based upon general statements by the Commission and the Staff of the Commission, it's unlikely

that the testimony could have shed any numerical light on it that would allow us to make quantitative judgments on the subject.

Q Well, maybe this is unfair characterization. I am trying to understand exactly what you are saying and if it's unfair, tell me so.

Are you saying that testimony regarding the site specifi seismic conditions is not relevant or important to the qualitative judgment made by Staff regarding external events?

A (WITNESS HULMAN) No, I am not saying that it's not relevant. I think any testimony on site specific conditions or earthquakes, seismology or any other kind of external event is very relevant in terms of quantifying the probability and consequences of severe reactor accidents from such events, the Staff generally believes it's beyond the state of the art to do so with much confidence at all.

Q So because it's beyond the state of the art to quantify in the judgment of Staff, then it's not necessary to know site specific considerations?

A (WITNESS HULMAN) It's necessary to know site specific considerations for design, for determining design bases, very important.

That's what our SER is all about, that's what our

design criteria is all about, that's what our standard review plan and many of our regulatory guides are all about.

In terms of quantifying the probabilities of severe accidents from such events, we believe the probabilities are not easily or well-quantifiable. That's not quite good English, but I think you understand what I mean.

Q Okay. Well, if the Applicant meets the design base criteria, then does the Staff analysis or judgment go any further beyond that or does that end the question?

A (WITNESS HULMAN) I don't know what question you are raising.

Q Well, the question of a consideration of accident risks from external events.

A (WITNESS HULMAN) In terms of the safety of the plant, in terms of whether adequate design has been incorporated in the plant to cope with severe external events, if the Applicant meets the appropriate standard review plan criteria and the Regulatory Guide and the regulations dealing with that subject, adequate safety has been provided.

In terms of assessing the consequences of events beyond the design bases, one can assess the consequences but one can't quantify the risk unless one knows the probability of the events; and the Staff doesn't believe

that one can quantify those probabilities very well at all.

Q Okay. I think I understand.

What was the impetus for the changes on Page 4 of the testimony?

A (WITNESS HULMAN) One primary impetus, clarification.

JUDGE SMITH: How did you become aware of the need for clarification?

MR. THOMAS: I am sorry. I didn't realize he was addressing a question to me.

JUDGE SMITH: No. I am addressing it to someone on the panel.

MR. THOMAS: Okay.

JUDGE SMITH: How did you become aware that the testimony had to be clarified?

A (WITNESS HULMAN) I was out of town at another hearing when this testimony was finalized.

Last night when I read for the last time what had been filed, I found that it did not convey the intent or meaning that it should have conveyed.

JUDGE SMITH: Have you completed? Are you done?

A (WITNESS HULMAN) Yes.

JUDGE SMITH: Independent of the in-camera testimony?

A (WITNESS HULMAN) I am sorry. I don't understand.

JUDGE SMITH: Independent of the testimony that we have had here on sabotage?

A (WITNESS HULMAN) Independent of that testimony.

JUDGE SMITH: So this is a consequence?

A (WITNESS HULMAN) Yes.

JUDGE SMITH: Well, we have had testimony in this hearing room about the likelihood of sabotage at the plant and that's an issue, and suddenly you come to the hearing room and you add that issue to your testimony and we are just trying to figure out if ther. is a relationship.

A (WITNESS HULMAN) To my knowledge, I did not know that you had previous testimony on sabotage when I determined that this was not adequate.

JUDGE SMITH: Okay.

BY MR. THOMAS:

Q If we have or if you have so little information regarding external events, including sabotage, what is the basis for the conclusion that the Staff's last estimate of accident risks from external causes for Byron is in the range predicted for Indian Point and Zion?

A (WITNESS HULMAN) You have made a statement and asked a question. I think your statement is incorrect and I think I cannot answer your question as asked because we have changed that portion of the testimony.

Q All right. I am trying to integrate the questions into my questions but it's a little difficulty, so go on.

A (WITNESS HULMAN) You asked the question but you made a statement first that says -- that said words to the effect that we know so little about external events, that's not what I have previously said.

Q Well, you said you didn't know enough to make a probabilistic assessment; is that correct?

A (WITNESS HULMAN) That's correct. We know a great deal about external events in terms of their causes and consequences.

What we do not know very well at all is the probability of very severe events on the order of one chance in a thousand or less. I have only been here less than 50 years. We have records on some events that only go back 50 years. Others we have records that go back a couple of hundred years.

Estimating the probability of a severe earthquake or a flood that has a likely hood of one chance in a thousand or less than is pretty uncertain. We don't have the experience to do so.

Q Well --

JUDGE SMITH: I --

MR. THOMAS: Excuse me, your Honor.

BOARD EXAMINATION

BY JUDGE SMITH:

Q As I recall from another hearing in which I was a Board member, we had Staff testimony that the figure ten to the minus sixth or ten to the minus seventh as a safety objective was applied by the Staff solely to external events.

Have I restated enough from my memory to help -- to ask you to articulate the correct question for me?

A (WITNESS HULMAN) Let me see if I can characterize what I think you are driving at.

The Staff in the past for design basis assessments has said that they would like to see each external events design basis protect against a severe accident for events more likely than one chance in a million. That is, we want to protect the public from one in a million chance earthquakes and floods and tornadoes and the like external event.

That pushes the state of the art and there are some people in the different technologies, seismology, hydrology, meteorology and the like, which believe one cannot make those estimates very well; but the Staff has used that as a guideline.

JUDGE SMITH: On external events.

A (WITNESS HULMAN) On external events for design purposes.

For PRA's it would be necessary to hypothesize

events with even less likelihood and we just don't believe that you can do it very well at all.

BY JUDGE SMITH:

Q So on a particular design basis consideration by engineering judgment, you can, you believe, quantify sufficient to have a useful guideline as compared to a PRA for an entire plant?

A (WITNESS HULMAN) Staff is divided on the subject. It depends on what the specific event is.

In the area of meteorology with tornadoes, professionals in the field believe that one can quantify the likelihood and magnitude of a tornado that has a probability of one chance in a million.

In seismology, the professionals seem to be divided. Some people believe that it is possible to estimate probability of a severe earthquake with that accuracy, trying to get at a one-in-a-million event.

In hydrology, it is also -- the community is also divided.

In sabotage the community doesn't seem to be divided. The community seems to have a collective consensus that one cannot estimate the likelihood at all.

Q Because of the human aspects of it?

A (WITNESS HULMAN) Principally because of the human aspect.

So the collective judgment of the different

technical communities involved in external events doesn't seem to exist with -- there doesn't seem to be any collective judgment.

MR. THOMAS: Well -- I am sorry. Are you --

JUDGE SMITH: No. That is fine.

BY MR. THOMAS:

Q I am trying to understand the statement on Page 4. You say, "For Zion, the Licensee" -- meaning Commonwealth Edison; right?

A (WITNESS HULMAN) Right.

Q -- "has submitted a probabilistic risk assessment which indicates external events can be significant contributors to risk." Right?

A (WITNESS HULMAN) Correct.

Q Now, I take it from what you have just told Judge Smith that the Staff does not feel collectively or there is not a consensus that this is a reliable assessment?

A (WITNESS HULMAN) I am having trouble with the word "reliable."

Q Well, let me put the question of, you know, if Commonwealth Edison can do it, why can't the Staff do it?

A (WITNESS HULMAN) Anybody can make a numerical estimate.

Q Right. But the question is its reliability; is that it?

A (WITNESS HULMAN) Its reliability, its accuracy and its use.

Q Well, what is the Staff judgment on Com Ed's PRA for Zion?
A (WITNESS HULMAN) That the Licensee, Commonwealth, made an estimate from the risks of external events; and I have attempted to characterize that quantification in the text of this testimony; that is, that the risks from external events are estimated by Commonwealth to be approximately ten times those from internal events.
Q Do you think that that estimate is reliable?
A (WITNESS HULMAN) No.
Q When you say -- I mean does that answer?

Are you speaking for the Staff now rather than just your personal opinion?
A (WITNESS HULMAN) I am not speaking for the Staff. I am giving you my professional judgment.
Q Now, you say for Indian Point evaluations by the Staff also indicate significant risks due to external events.

The question is: What Staff evaluations went into that conclusion or indication?
A (WITNESS HULMAN) A considerable number of Staff evaluations of external events at Indian Point was conducted, including some contractual work at Sandia National Laboratories and by private consultants employed by Sandia Laboratory.

What is in the text of our testimony is what the Staff has concluded that the risks from external events

could be 30 times as high.
Q Were any of those evaluations regarding Indian Point probabilistic risk assessments?
A (WITNESS HULMAN) Yes.
Q In the Staff judgment, if you can give such a judgment, are those assessments reliable?
A (WITNESS HULMAN) I cannot give you the Staff judgment. Staff has testified in the Indian Point proceeding that the Staff generally agrees with the characterization.
Q Well --
A (WITNESS HULMAN) By the way, the Staff's testimony does indicate the uncertainties associated with external events at Indian Point are very large. The reliability of the assessments has been questioned.
Q If a probabilistic assessment was made by the Staff or under the egis of the Staff for Indian Point, why did the Staff not make such an assessment for Byron?
A (WITNESS HULMAN) Two basic reasons. The first reason is that such assessments have to be pretty site specific to be effective. We couldn't use the earthquake history in California to estimate the likelihood of an earthquake at the Byron site very well. That is obvious.
Q Well, it's not so obvious, given some of the testimony in this case and that's why I laughed.
I am sorry. I apologized.

All right. Must be site --

MR. GALLO: I take it counsel is withdrawing his comments from the record?

MR. THOMAS: I will.

BY MR. THOMAS:

Q It must be site specific, okay.

A (WITNESS HULMAN) Secondly, there is no need dictated by any guidance to the Staff or to the Applicant in this particular case necessitating such an assessment.

Q When you say there is no need, you mean there is no regulation requiring such?

A (WITNESS HULMAN) There is no regulation, policy or Staff practice.

Q Well --

JUDGE SMITH: Are you witnesses in Indian Point, too?

A (WITNESS HULMAN) I was not a witness at Indian Point but I was at the hearing and a member of my Staff was a principal witness at the hearing.

BY MR. THOMAS:

Q You say one of the reasons it was not done at Byron was that such an assessment must be site specific?

A (WITNESS HULMAN) Correct.

Q How is that an objection to doing one for Byron or why is that an objection, why couldn't it be site specific?

A (WITNESS HULMAN) One could be done. One has not been done, but one was not required, either.

JUDGE SMITH: That still doesn't -- the opening thread of your cross examination was, "if you could do one at Indian Point and if you could do one at Zion, why not Byron?"

MR. THOMAS: Right.

JUDGE SMITH: I think that that thread has been lost.

MR. THOMAS: Okay. He gave me two reasons, and one was he said there was no need because no regulation, et cetera, requires it.

The second one he says it has to be site specific. That's what I am trying to explore why.

A (WITNESS HULMAN) I think it's easy to answer.

MR. THOMAS: The question is the same.

JUDGE SMITH: Why don't you give us -- in other words of explanation, if that would be helpful.

MR. THOMAS: I don't mind.

JUDGE SMITH: You can explain the confusion that --

A (WITNESS HULMAN) The Commission ordered an assessment of the risks at Zion and Indian Point because of their relatively high population density.

They did not order such an assessment at Byron.

BY MR. THOMAS:

Q All right. But there was certainly nothing preventing doing such an assessment?

A (WITNESS HULMAN) We don't regulate by nothing preventing, asking the question. We follow practice, the regulations and procedures.

Q So to answer my question, there was no reason why it couldn't be done; is that correct?

A (WITNESS HULMAN) There is no reason why it could not be done.

Q Thank you.

Well, since one could have been done for Byron, why is the Staff's best estimate of accident risks from external causes at Byron based upon Zion and Indian Point?

A (WITNESS HULMAN) I think I have done that once before. Let me try again another way.

Zion and Indian Point are special cases. They have operating licenses and in those particular cases because of apparent concern over high population densities, the Commission asked the Staff and the licensees to assess in detail the risks from those plants.

We have an interim policy statement that the Staff uses to review risks at plants for which we will grant either construction permits or operating licenses. Zion and Indian Point already have those licenses. Byron does not.

The policy statement that guides the Staff and guides applicants for construction permits and operating licenses does not require a detailed PRA.

JUDGE SMITH: Is it a question of the Commission allocating the Staff resources where they believe the best safety benefit will be?

A (WITNESS HULMAN) No, sir. The Commission made a specific statement in June, 1980, not to require detailed PRA for construction permit applications and operating license applications.

It did ask for an assessment of risks that led to PRA's for Zion and Indian Point, but they already had their operating licenses. It's been almost a plant-by-plant decision except for the interim policy statement, where the Commission was fairly straightforwad not requiring PRA's.

Q So the Staff estimate in this case was based upon Zion and Indian Point, because you had PRA's for those sites and none was required for Byron; is that correct?

A (WITNESS HULMAN) Basically, yes.

Q Then you say that the Staff's best estimate of accident risks from external causes could be higher than what has been presented in the FES.

How much higher could it be?

A (WITNESS HULMAN) The supplemented testimony gives you the

answer to that question. The testimony says, "less than a factor of 100 higher."

BOARD EXAMINATION

BY JUDGE SMITH:

Q In your supplemental testimony, your reference to the risk multpliers computed for Indian Point and Zion, those multpliers being what? What is that?

A (WITNESS HULMAN) In the previous paragraph, the third line from the bottom, the 30 higher for Indian Point and in the next to the last line, ten times higher for Zion.

Q Those are the multpliers?

A Those are the multpliers.

Q Are those multpliers based on population?

A (WITNESS HULMAN) In part. There are substantial differences in population density between Byron, Zion and Indian Point, Zion and Indian Point being substantially higher.

BY MR. THOMAS:

Q Do you know what external events were considered in the design and Indian Point studies that are identical or similar to external events which could produce accident risks at Byron?

A (WITNESS HULMAN) I have trouble with the question.

Q Okay. Let me try and put it this way.

Are there any external risks -- excuse me.

Are there any external causes or events -- strike that. Let me start over.

Are there any external events that could occur at Byron that were not considered in the Zion and Indian Point studies?

A (WITNESS HULMAN) I don't know, since a detailed assessment of this plant and its site has not been done, I can't answer your question.

Q Okay.

A (WITNESS HULMAN) It's got to follow.

Q Pardon?

A (WITNESS HULMAN) It's got to follow.

Q Yes.

Do you know on what basis the Staff extroplated from the Zion and Indian Point studies to arrive at its best estimate in this case?

MR. RAWSON: Objection. I don't think there has been testimony, Judge, that the Staff extroplated from Indian Point.

MR. THOMAS: Judge, the testimony indicates the Staff best estimates of accident risks from internal and external causes exclusive of sabotage and based upon what has been learned at Zion and Indian Point.

Now, based -- you know, in some way it seems from the testimony in some way the Zion and Indian Point

studies perform the basis for the Staff's best estimate in this case. That's what I am trying to determine.

MR. RAWSON: My point, Judge Smith, is perhaps a quibble as we have used the points here, but I am concerned about the form of the question as it uses the term extroplate. It is my understanding that the term, extroplate, may be a term of art in this area and I don't want us drawing assumptions from the use of that term here that have not been substantiated by the record and by the testimony of these witnesses.

MR. THOMAS: Well, I am not led to the word extrapolate.

With the Board's permission, I will withdraw the question and put another one.

BY MR. THOMAS:

Q How were Zion and Indian Point studies used to arrive at the best estimate of accident risks in this case?

A (WITNESS HULMAN) Engineering judgment. No site specific information, no detailed PRA of this particular reactor and its associated external event risks.

Q When you say engineering judgment, do you mean somebody said, "Well, here is Zion and here is Indian Point and I can think of no reason why Byron is any different?" Or significantly different?

A (WITNESS HULMAN) Significantly different.

Q But otherwise that's a fair description of the process?
A (WITNESS HULMAN) Yes, and it was generally a consensus among the professionals that deal in external events and accident risk assessments on the Staff.
Q Okay. Thank you.

BOARD EXAMINATION

BY JUDGE SMITH:

Q In your statement there on Page 4, supplemented, the language, "What has been learned at Zion and Indian Point," that was a quote, in reference to the PRA's for those plants --
A (WITNESS HULMAN) Yes, sir.
Q But did I understand you to say, however, earlier in your cross examination testimony that you do not believe that the PRA at Zion produces reliable results?
A (WITNESS HULMAN) That is correct. Somebody made an estimate.
Q Okay. So --

JUDGE SMITH: Okay. Go ahead.

BY MR. THOMAS:

Q In Answer 7 on Page 5, you indicate that the Staff is undertaking the development of a program plan for improving the capability of external events PRA methodology.

Can you tell me what that program plan consists of?

A (WITNESS HULMAN) It hasn't yet been developed.
Q Well, it's expected to be completed by early summer, 1983; is that correct?
A (WITNESS HULMAN) That's correct.
Q Do parts of the plan exist?
A (WITNESS HULMAN) No, sir.
Q None of it?
A (WITNESS HULMAN) The first meeting of the principals, which I missed, was today.
Q Do you know whether this plan will be applied to Byron as it becomes available?
A (WITNESS HULMAN) No.
Q Do you have an opinion on the subject?
A (WITNESS HULMAN) If the plan is successful, I believe that eventually every reactor will be considered with respect to risks from external events.

I have no idea when, but I believe, if successful, such will be done.

Q What would be the consequences in such an event if it were determined that the accident risk of external events or from external events were unacceptably high?

MR. RAWSON: I am sorry, Judge.

May I have the question re-read, please?

JUDGE SMITH: Please.

(The question was thereupon read by the

Reporter.)

MR. RAWSON: Thank you.

(WITNESS HULMAN): May I answer?

JUDGE SMITH: There is no objection.

A (WITNESS HULMAN) Okay. Much the same thing that has happened with the Staff evaluation and the licensee's evaluation at Indian Point. Fixes would be made, both by design changes -- construction is what I mean by "fixes" -- both by the licensee and at the request of the Staff. That has happened at Indian Point.

I anticipate the same thing to happen at other reactors, including Byron.

BY MR. THOMAS:

Q In your opinion, is it likely that the fixes would be more expensive to implement after an operating license had been granted as opposed to before an operating license were granted?

MR. GALLO: Objection. The question calls for speculation on behalf of the witness.

It's an unfair question, to boot, because the witness has been given no clue as to what kinds of changes and fixes are in the mind of Mr. Thomas when he asks the question.

MR. THOMAS: This is not even counsel's witness, let alone being the --

JUDGE SMITH: Well, he is bound by the answers, however. They will all be part of the record upon which his client's fortunes rest. He has the standing to make the objection.

MR. THOMAS: Well, I still think that is a matter for the witness as opposed to counsel for the Applicant.

JUDGE SMITH: Can you answer the question as it was --

A (WITNESS HULMAN) I think I would have to speculate.

There would be some kinds of design changes and fixes that would be more expensive and there may be some that are less.

MR. THOMAS: I think that is a fair answer under the circumstances.

JUDGE SMITH: Yes, except we don't normally favor pure speculation as a basis for our decisions.

MR. THOMAS: I understand; but somehow it seems that some element of that creeps into this, into this hearing, dealing, as we are, with the subjects.

BY MR. THOMAS:

Q Can you tell me: What was the cost of the fixes at Indian Point and what the fixes were that were implemented there?

A (WITNESS HULMAN) I cannot tell you what the costs were.

I am aware of a couple of fixes in detail. The

remainder I don't remember.

Q Can you briefly describe the fixes that you do remember?

A (WITNESS HULMAN) There was a seismic design fix on one of the units at Indian Point, because of an apparent inadequacy in design with respect to the control room and the control room walls and ceilings. A very severe earthquake might cause a failure of the control room ceiling and lead to a severe release.

Some design changes and improvements in the structural capability of the control room building were made.

The procedural fix was a procedure to reduce the likelihood and consequences of a hurricane-induced core melt, a procedural fix in the way of providing for shutdown of the reactor well in advance of a hurricane, cooling that reactor down and providing for emergency procedures to keep the core cooled should the hurricane strike the plant were imposed at Indian Point.

Q Okay. Now, referring to Page 7, Answer 10 -- I guess this would be Mr. Wohl -- it states there that the fault tree/event tree approach, coupled with an adequate data base, is the best available tool with which to quantify the accident probabilities associated with nuclear reactors; is that right?

A (WITNESS WOHL) That's right.

Q Are you familiar with any of the following methodologies developed in the aerospace field over the past 15 years:

First of all, probabilistic design analysis?

A (WITNESS WOHL) Not specifically.

Q Propagation of error techniques?

A (WITNESS WOHL) If you are asking me whether I am familiar in the sense of being a user or just having heard of that, I have heard about it but I am not a user.

Q I am speaking of user, because I will ask you some follow-up questions which you couldn't answer if you had just heard of it.

So you are not familiar as a user with --

A (WITNESS WOHL) That's correct.

Q Okay. What about reliability estimation from small sample sizes?

A (WITNESS WOHL) No, I am not a user of that.

Q And what about malfunction simulation models?

A (WITNESS WOHL) No.

Q Is it fair to say that nobody on the panel is familiar with any of these methodologies?

A (WITNESS HULMAN) I think there is some familiarity with some of the methodologies.

I for one have used error propagation methodology in one context or another. Okay?

Q Well, do you feel qualified to compare that method with

the fault tree approach?

A (WITNESS HULMAN) No. I have not done such.

Q Okay. Does anybody on the panel feel qualified to compare any of those methodologies with the fault tree approach?

A (WITNESS BRANAGAN) No.

A (WITNESS WOHL) No.

A (WITNESS HULMAN) No.

A (WITNESS NEWBERRY) No.

Q With regard to the WASH-1400 Study, you discussed the application of that to a prototype pressurized water reactor at survey; is that right?

A (WITNESS WOHL) Yes.

Q You, of course, were here this morning when we went through these matters with Mr. Levine.

In your opinion, is the Surry PWR comparable to the Byron PWR's for these purposes?

A (WITNESS WOHL) For these purposes, I think that it's adequate in terms of making an adequate representation of the event sequences that we use to represent possible events occurring.

Q You would agree that Byron has a different design basis than Surry and operator training and various other different features?

A (WITNESS WOHL) I don't understand what you mean by "a different design basis."

Q Well, Surry is a three loop, for example, and Byron is a four loop, isn't it?

A (WITNESS WOHL) That doesn't mean the design basis is different. It means the design is different.

Q The basic design is. All right.

I am not going to go through all of that again.

Directing your attention to Page 9, Answer 12, which I guess is the of Mr. Newberry.

Regarding your discussion of the precursor study, do you feel that that is applicable to Byron, since large reactors like Byron have only 10 years of operating experience?

A (WITNESS NEWBERRY) Excuse me. What is applicable?

Q The precursor study -- the results from the precursor study, I guess.

A (WITNESS NEWBERRY) The results of the precursor study are --

Q What you discuss in the answer there.

A (WITNESS NEWBERRY) -- only are applicable to plants operating between 1969 and 1979, which Byron was not one of.

Q So I guess, then, your answer would be that it's not applicable?

A (WITNESS NEWBERRY) I would give a qualified answer.

I think the -- I discuss in my answer to Question 13 why the estimates are certainly different.

However, I think there is information in the precursor study that -- you know, what caused precursors, what sequence dominated precursor study; that those sequences would be, in some sense, applicable to Byron.

Q Okay. But the frequency of severe core melt -- excuse me.

The frequency of severe core damage accidents, those estimates would not?

A (WITNESS NEWBERRY) That's right. I would say that frequency of severe core damage, as calculated by the precursor study, is not really applicable to a plant like Byron.

MR. THOMAS: Excuse me a moment, your Honor.

BY MR. THOMAS:

Q Directing your attention to the same answer, could you expand a little more on what you mean by the sentence, "We do not differentiate between severe core damage and core melt in this testimony since analyses have not been refined to differentiate the fraction of core melt events that may terminate at severe core damage?"

A (WITNESS NEWBERRY) Yes. I think the testimony of Mr. Levine previously covered this in some detail.

Q Okay. Well, that's -- I thought he did differentiate it.

MR. RAWSON: Excuse me. Has the witness finished with his answer?

It seemed to me that was a lead in to something

broader.

MR. THOMAS: I wasn't trying to cut him off.

Please finish your answer.

A (WITNESS NEWBERRY) (Continuing.) I was only saying here that there certainly is a difference -- okay? -- between severe core damage and what is termed to be a core melt as used in probabilistic risk assessments.

I did not -- I used -- I made a comparison of the severe core damage frequency in the precursor study with core melt estimates, if you will, in WASH-1400.

MR. THOMAS: I am sorry. Does that complete your answer?

(WITNESS NEWBERRY): Yes.

JUDGE SMITH: Are you saying you used the two terms in the same sense that Mr. Levine used them?

(WITNESS NEWBERRY): Well, yes, sir. I think the definitions that he gave for severe core damage and core melt were correct and I would agree with that.

The precursor study calculates a frequency of severe core damage.

Now, given a severe core damage, the conditional probability of -- beyond that of proceeding to a severe core melt, where the entire core melts through the vessel and challenges the containment, I don't know what that is. That's being looked at.

I did not, in this testimony, go into that in any detail.

JUDGE SMITH: Proceed.

BY MR. THOMAS:

Q How does this relate to WASH-1400?

MR. RAWSON: I object to the form of the question.

Unless we can have some sort of specificity to what this refers to, the witness is not going to be able to, obviously, answer that.

MR. THOMAS: It refers to the distinction that we just discussed in your preceding answer.

MR. RAWSON: Thank you.

(WITNESS NEWBERRY): I guess I should make sure I understand.

This is the diffferentiation between severe core damage and --

MR. THOMAS: Right.

(WITNESS NEWBERRY): Would you please restate the question? I am still confused.

BY MR. THOMAS:

Q The question is: How does this relate to WASH-1400, this distinction that you are drawing or that you discuss?

A (WITNESS NEWBERRY) Well, simply that WASH-1400 calculates the date frequency of core melt rather than severe core

damage.

JUDGE SMITH: Excuse me. Before we get too far away from this point and my question, Mr. Levine, I wonder if you would look at Page 9 and A 12 and tell us in your view if you used the terms in response to Dr. Cole's questions in the same sense that you believe that Mr. Newberry has used it?

MR. LEVINE: I agree that, if he accepts my definitions, his descriptions are correct --

JUDGE SMITH: Are correct.

MR. LEVINE: -- his descriptions of the frequencies.

JUDGE SMITH: I don't mean the frequencies. The use of the words, "severe core damage and core melt."

I heard the testimonies of the two gentlemen to actually reverse the use of the terms.

MR. LEVINE: I thought he said he accepted my definitions.

JUDGE SMITH: I am asking: Do you accept his definition?

MR. LEVINE: Well, I haven't heard him define them.

JUDGE SMITH: I was referring you to Answer 12 on Page 9.

MR. LEVINE: I am looking.

He has not defined them.

(WITNESS NEWBERRY): That is correct.

May I try again, Judge?

JUDGE SMITH: Yes.

MR. GALLO: Excuse me, your Honor.

Is the Board question that Mr. Newberry says in his answer that he doesn't differentiate between the two terms? Does that cause the confusion?

JUDGE SMITH: No. The confusion I have is that he says a core-melt event may terminate at severe damage, implying that others may not.

MR. LEVINE: I think, if I may -- may I try to clarify that, Judge?

JUDGE SMITH: Yes, sir.

MR. LEVINE: I think what he is saying is that some fraction of accident sequences that might proceed to core melt could, in fact, be terminated before core melt and result in core damage.

So the ideal --

JUDGE SMITH: That's exactly right. That is where I think --

MR. LEVINE: It's sort of a misnomer to call them core-melt sequences. He should talk about accident sequences which, if allowed to proceed to their end procedure, result in core melt. It could be terminated

before that point and result in core damage. In one reads it that way, that might clarify it.

JUDGE SMITH: Did you want to comment?

(WITNESS NEWBERRY): No, sir. I think that was pretty well stated.

JUDGE SMITH: All right, thank you.

MR. THOMAS: May I proceed, your Honor?

JUDGE SMITH: Yes, please.

BY MR. THOMAS:

Q All right. Would it be accurate to say then, in your estimation, that the precursor study never -- did not estimate the frequency of the worst-case scenario; that is, a core melt as opposed to core damage? Would you agree with that?

A (WITNESS NEWBERRY) Well, I would say it this way: The precursor study is dominated by the Three Mile Island accident, the frequency calculated in the precursor study.

Q Which was core damage as opposed to core melt?

A (WITNESS NEWBERRY) Which was core damage as opposed to core melt; that is correct.

Now, using the methodology that Mr. Levine outlined, they calculated probabilities of proceeding beyond a precursor, approaching a severe core damage, or, perhaps, a core-melt state; in that sense beyond the precursor.

I don't believe they differentiate to severe core

damage or core melt.

Perhaps the sequence could be terminated, with some recovery, at severe core damage, but that refinement, I don't believe, is made in the precursor study.

JUDGE CALLIHAN: Excuse me, Mr. Thomas. May I inject something here?

MR. THOMAS: Sure, Judge.

BOARD EXAMINATION

BY JUDGE CALLIHAN:

Q I have trouble with that sentence, "Differentiate," and for completeness -- this is your answer to Question 12, which appears on Page 9, and it's the sentence that begins about midway, which starts, "We do not differentiate," and so forth. It's the second use of the word "differentiate."

Differentiate what from what? A (WITNESS NEWBERRY) The second differentiate?

Q Yes. Differentiate a fraction of core-melt events that may terminate at severe core damage, differentiate that from what?

A (WITNESS NEWBERRY) A fraction of core melts that may terminate at severe core damage as compared to the core-melt events that don't terminate at severe core damage but proceed to a core melt, which would ultimately challenge the containment safeguard systems, potentially

lead to a large release.

Q Are these events that may terminate at severe core damage potential core-melt events but something else happens before the melting actually occurs?

A (WITNESS NEWBERRY) Yes, sir.

At Three Mile Island the operator eventually shut the blocked valve and stopped the LOCA and initiated injection of water into the system and eventually entered a more stable condition and did not proceed to a full core melt.

BOARD EXAMINATION

BY JUDGE COLE:

Q My problem with that is: It was not a core-melt event then?

A (WITNESS NEWBERRY) That's correct.

Q So it's the fraction of events that may terminate at severe core damage, not the fraction of core-melt events?

JUDGE CALLIHAN: That's the reason why I want to put the word "potential" in, the fourth to the last line, preceding core melt, "The fraction of potential core-melt events that are

terminated by or terminate at severe core damage.

Does that word "potential" help any?

(WITNESS NEWBERRY): Yes, sir.

I think just my practice called multiple failure

proceedings or core melts. They are just frequently called core-melt events, but in this case, being more specific, I think the word "potential" helps.

JUDGE SMITH: Mr. Levine.

MR. LEVINE: May I just suggest an addition? The word "event" is changed to "accident sequences," so we have "potential core melt accident sequences," then it would be very clear in reading. That's the point I made earlier.

JUDGE SMITH: That was the ambiguity that led me to believe the terms were being reversed in the differing testimony.

MR. LEVINE: Exactly.

JUDGE CALLIHAN: If we look at it --

JUDGE COLE: Would you adopt that change, Mr. Newberry?

(WITNESS NEWBERRY): Let me read it.

JUDGE CALLIHAN: Let me ask one thing first. Then would it help to say, "Potential core melt accidents that are terminated at severe core damage?"

(WITNESS NEWBERRY): Yes. Once you put in the "potential," I think the "may" can become an "are," and I would agree.

MR. THOMAS: Would you read the sentence now --

JUDGE SMITH: What we will want, when this is

all done, not only for him to read the sentence, but to retrieve the actual testimony and make the change, write the change in the testimony.

MR. THOMAS: I think it would be a good idea if we did that with Page 4, too, because it's very difficult to read.

JUDGE SMITH: Page 4 is already -- that has already been done with respect to Page 4.

MR. THOMAS: In typed form?

JUDGE SMITH: No, no. In handwritten form.

MR. THOMAS: Okay. Well, you --

JUDGE SMITH: If you would like to ponder the actual language you want, maybe we can take a break.

We will be breaking promptly at 5:00 this evening.

Maybe we will take a few minutes to give you a chance to really think about it and then we can make sure it's accurate and just the way you intend the testimony to be.

MR. THOMAS: Do you want to do that now?

JUDGE SMITH: Well, whatever time he needs. I just want him to have all the time he needs to do it carefully and be precise in the way he wants it.

(WITNESS HULMAN): We would suggest we bring it in in the morning.

JUDGE SMITH: The problem is, the testimony will

be brought in tonight.

If you need that time, we will just mark on the testimony.

(WITNESS HULMAN): He says he can do it right now.

JUDGE SMITH: Okay.

MR. GALLO: Your Honor, perhaps a short recess would help him.

JUDGE SMITH: All right. We will take a few minutes.

MR. THOMAS: Judge, do you want to just recess for the evening? It's 10 to 5:00 now.

I am not going to finish.

JUDGE SMITH: There is no reason why we have to come back. I think we have a comfortable amount of time and we should be able to finish up tomorrow.

MR. THOMAS: No question.

JUDGE SMITH: Except that the parties -- when he makes his correction, the parties should have an opportunity to approve the corrections so that we all can address it.

Are you ready for it now?

(WITNESS NEWBERRY): No, sir.

JUDGE SMITH: Except for this, let's adjourn, and if we have to go back on the record, we will; but we

will meet tomorrow, then, at 9:00 A. M.

MR. THOMAS: Thank you.

(Whereupon at 4:50 P. M., the hearing in the above-entitled matter was recessed, to reconvene at 9:00 A. M. on Wednesday, March 16, 1983.)

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

ATOMIC SAFETY AND LICENSING BOARD

in the matter of: COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station, Units 1 & 2)

Date of Proceeding: March 15 , 1983

Docket Number: 50-454-OL and 50-455-OL

Place of Proceeding: ROCKFORD, ILLINOIS

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

G. Allen Sonntag

Official Reporter (Typed)

Official Reporter (Signature)