4/20/82

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

APPLICANT'S REBUTTAL TESTIMONY
OF JACOB I. FABRIKANT
ON CONTENTION 8/9

Question:

Please state your name, your academic qualifications, your areas of professional training, responsibilities, interests and activities.

Answer:

My name is Jacob I. Fabrikant. I hold a Bachelor of Science degree in chemistry and mathematics, McGill University; a Doctor of Medicine degree and a Master of Surgery degree, both from McGill University; and a Doctor of Philosophy degree in biophysics, University of London. I am a Fellow of the American College of Radiology. I did post-doctoral training in surgery and pathology at Duke University Hospital, and trained

in radiology at The Johns Hopkins Hospital. I am certified by the American Board of Radiology in diagnostic radiology, therapeutic radiology and nuclear medicine. I have been Professor and Head of the Department of Radiology, University of Connecticut School of Medicine; and Professor and Chairman, Department of Diagnostic Radiology, McGill University Faculty of Medicine. I am presently Professor of Radiology, University of California School of Medicine at San Francisco; Staff Senior Scientist at Lawrence Berkeley Laboratory, University of California, Berkeley; Physician-in-charge of the Donner Pavilion, Cowell Memorial Hospital, University of California, Berkeley; and Member of the Graduate Biophysics Group, Department of Biophysics and Medical Physics, University of California, Berkeley. I devote all my professional and academic activities to patient care, primarily in diagnostic and therapeutic radiology and nuclear medicine; to research in the radiological sciences, primarily cancer research; and to teaching in radiology and biophysics, primarily in the radiological sciences in the medical school and in the graduate school at the University of California. These are all documented in my curriculum vitae which is attached to this testimony.

Question:

Have you ever been appointed to or served or do you presently serve on any recognized national or international committees, commissions, or groups dealing with the radiological sciences in general, and radiation and health in particular?

Answer:

Yes. I have served on five committees of the National Academy of Sciences - National Research Council, including the BEIR I, BEIR II and BEIR III. I presently serve on a National Academy of Sciences committee on a NIOSH study of the Portsmouth Naval Shipyard Workers, and I am consultant to the National Academy of Sciences Board of Radioactive Waste Management. I was the Director of Public Health and Safety of The President's Commission on the Accident at Three Mile Island. I have served on advisory scientific committees of the President's Commission, USPHS, NIH, NCI, BRH, NASA, American College of Radiology, the NRPB of Canada and England, and other bodies dealing with radiation and health and cancer research. I am a member of the International Commission on Radiological Protection.

Question:

Have you ever published in the scientific literature dealing with medicine, cancer research, radiation and health?

Answer:

Attached to my testimony is a complete bibliography of my publications. My publications now number in excess of 200 scientific articles, reports, chapters and reviews in the open

literature. They are all in the fields of radiological sciences, medicine and surgery, radiobiology, radiation and health, cancer biology, and related disciplines.

Question:

Have you reviewed the testimony of Dr. Irwin D. J. Bross which appears in the transcript of March 30 and 31, 1982, in this proceeding?

Answer:

Yes.

Question:

Directing your attention to Dr. Bross's answer to Question 19 in his prefiled testimony, do you share his assessment of the validity of the biostatistical techniques and the estimation of risk in the BEIR III Report?

Answer:

No. Dr. Bross fails to recognize that the BEIR III Report is a Committee Report of the National Academy of Sciences - National Research Council that responded to a particular task proposal. The task before the BEIR III Committee was specified in detail in an agreement accepted by the National Academy of Sciences on September 30, 1976 (NAS-BEIR III Report: 1980, p.9). Two provisions of the task included: (1) review the current state of knowledge on somatic and genetic effects of ionizing radiation, and (2) make recommendations on the potential risks from ionizing radiation as may be justified on the basis of current published scientific information.

Accordingly, a group of 25 scientists with established scientific reputations in the fields of biology, genetics, cytogenetics, embryology, mathematics, biostatistics, epidemiology, experimental medicine, pathology, radiology, nuclear medicine, oncology, public health, cancer research, environmental medicine, biophysics, cell biology, and radiobiology, constituted the working committee.

The Committee's report had a due date; a Committee decision was made to end review of all current published scientific information by the beginning of 1979 in order to provide the final report to the National Research Council in a responsive and timely manner for review by the National Academy of Sciences prior to final publication. By that time many hundreds of published references considered important to the task of the Committee had been carefully reviewed and recorded. Appendix B to Chapter V of the BEIR III Report (pp. 455 to 475) is a "Review and Analysis of Selected Studies on Record," and includes the published or available reports of Mancuso, Stewart and Kneale; Bross; Najarian and Colton; Sternglass; and Frigerio, Archer, and others. Eighty-six references are cited in this Appendix B, and these include all of Dr. Bross's published (and some unpublished) papers and letters relevant to the problems of low-level radiation and risk estimation available to the Committee.

The BEIR III Committee used biostatistical techniques and methods extant and considered applicable and appropriate for

analysis of the epidemiological data for estimation of risk coefficients for cancer. The techniques and methods are those used in radiation epidemiology and biostatistics as well as in other related areas of epidemiology and biostatistics by national and international groups, committees, universities and institutes, including biostatistics and epidemiology departments in universities such as Harvard, Johns Hopkins, Oxford, Cambridge, Paris, London School of Hygiene and Tropical Medicine, Stanford, Rochester, New York, Cornell, and many more; national agencies and groups, such as NIH, NCI, EPA, NCRP and NAS-NRC in the U.S.A., and others abroad, e.g., NRPB (UK) (National Radiological Protection Board) and NRPB (Canada); and international agencies and groups such as ICRP and UNSCEAR. There has been no published criticism from any of the above-mentioned institutions or groups to warrant the conclusion that the biostatistical techniques or methods for risk estimation used by the BEIR III Committee, or the risk estimates for radiation-induced cancer in the illustrative examples provided or derived from the scientific literature, were inappropriate, inaccurate, incorrect, or otherwise biased.

The sets of data and interpretations of data which have recently played a role in the public controversy over the potential risk of low-level radiation, particularly those tending to indicate that low-level radiation may be more hazardous than thought, were carefully reviewed by the BEIR III Committee (BEIR III Report: 1980, pp. 455 to 475). The overall

conclusion is that none of these reports, individually or collectively, changes appreciably or even significantly the evaluations of possible low-level radiation effects that have been made by the BEIR III Committee and by the several other authoritative national (e.g., NCRP, NRPB (UK)), and international (e.g., ICRP, UNSCEAR) groups.

The ICRP, Committee I, of which I am a member, constantly reviews these published "controversial" reports as they become available in the scientific literature. At the most recent meeting of the ICRP in December, 1981, all current published reports to date which are considered relevant, were reviewed. No additional information, data, interpretations, or current reports of low-level radiation carcinogenic (cancer-induction) or genetic effects, were introduced to alter the conclusions of the BEIR III Report. Those controversial reports reviewed in the Appendix B to Chapter V of the BEIR III 1980 Report can still be seriously faulted, and none is considered by any of the national or international groups to constitute reliable evidence at present for use in risk estimation for various reasons, including inadequate sample size in some instances, inadequate statistical analysis, and unconfirmed results.

Dr. Bross states that "[e]xtrapolation beyond the range of data is unacceptable, from a statistical standpoint . . . ." The BEIR III Committee chose not to extrapolate beyond the available human epidemiological data, where there is "little reliable information concerning the consequences of exposure to

lower doses, especially those low doses to which a human population might be exposed." (NAS-BEIR III 1980 Report, p. iii.

The BEIR III Committee after three years of deliberation and careful perusal of available scientific evidence found that its "most difficult task has been to estimate the carcinogenic risk of low-dose, low-LET, whole-body radiation. It recognized that the scientific basis for making such estimates is inadequate, but it also recognized that policy decisions and the exercise of regulatory authority require a position on the probable cancer risk from low-dose, low-LET radiation. Accordingly, the Committee decided that emphasis should be placed on the assumptions, procedures, and uncertainties involved in the estimation process, and not on specific numerical estimates." (NAS-BEIR III 1980 Report, pp. 2 to 3).

Finally, I note that at other points in his testimony (e.g., page 1523-24 of the transcript), Bross displays an ignorance of the BEIR III Report, which he finds "unacceptable." Bross apparently does not know the difference between BEIR II and BEIR III. It appears he assumes, incorrectly, that the 1979 edition of the BEIR III Report was the BEIR II Report. Had he read BEIR III, he would have known the history of the Committee's reports (see BEIR III 1980 Report, p. 9). I quote: "The BEIR Committee produced its report in November 1972: The Effects on Populations of Exposure to Low Levels of Ionizing Radiation (BEIR I) . . . . The Committee completed its

[second] report in 1976, and it was published in 1977: Considerations of Health Benefit-Cost Analysis for Activities Involving Ionizing Radiation and Alternatives (BEIR II). Page iii of the Report, President Philip Handler's letter, transmits the most recent Report, "'The Effects on Populations of Exposure to Low Levels of Ionizing Radiation [:1980]'. . . . familiarly known as BEIR III (after its authorizing Committee on the Biological Effects of Ionizing Radiations). . . ."

Furthermore, contrary to Dr. Bross's statement, there was no disagreement in the BEIR II Report on the linear hypothesis. Only the linear hypothesis was used for risk estimation and cost-benefit analysis in the BEIR II Report.

Further, "another report" (tr. 1524, line 15) of BEIR II did not come out; it was BEIR III. The 1980 BEIR III did not attempt "to paper over the differences between members of the BEIR Committee" but rather (quoting from President Handler's letter of transmittal, p. iii), "The report presents all of these views [of the Committee members], in balanced fashion. The committee as a whole, despite individual preferences, has agreed that the report treats each of the possible interpretations [of dose-response models for estimating risk] in a fair manner."

Question:

Do you agree with Dr. Bross's reply to Question 28, which appears in his prefiled testimony, "Qualitatively how does the health risk from low-level radiation exposure compare to the risk from high level exposure"?

Answer:

No. In recent years, a general hypothesis for estimation of excess cancer risk in irradiated human populations based on theoretical considerations, extensive laboratory animal studies, and available reliable epidemiological surveys, suggests various and complex dose-response relationships between radiation dose and observed cancer incidence. (BEIR III Report, 1980; UNSCEAR Report, 1977; NCRP Report No. 64, 1980). By far, the most widely considered dose-response model for cancer-induction by radiation is a multicomponent, non-threshold, dose-response curve which contains: (1) initial upward curving linear and quadratic functions of dose at low and intermediate levels of dose, and (2) a downward-curving function in the high-dose range (BEIR III Report, 1980; p.23).

For risk-estimation, the BEIR III Committee used a variety of dose-response functions that could be applied to the observed epidemiological data. (BEIR III 1980 Report, p. 21). These included the linear, the pure quadratic, and the linear-quadratic (quadratic with a linear term) dose-response models. The BEIR Committee preferred, for risk estimation of low-dose, low-LET, whole-body radiation, the linear-quadratic dose-response model. "Wherever possible, in estimating the cancer

risk from low doses of low-LET radiation, the [BEIR III] Committee has used a linear-quadratic dose-response model that is felt to be consistent with epidemiologic and radiobiologic data, in preference to more extreme dose-response models, such as the linear and the pure quadratic." (BEIR III Report, 1980, p.2).

In the application of the linear-quadratic dose-response model forms, "the [BEIR III] Committee recognizes that some experimental and human [epidemiological] data, as well as theoretical [mathematical and biophysical] considerations, suggest that, for exposure to low-LET radiation at low doses, the linear model probably leads to overestimates of risk of most cancers, but can be used to define the upper limits of risk." (BEIR III 1980 Report, p.2). This overestimate of risk is particularly the case at lower doses. Therefore, it must be concluded from the scientific evidence that insofar as radiation mutation and cancer induction are concerned, the risk per unit (low-LET) radiation dose at low-dose levels is less than the risk at high-dose levels.

And finally, there is little evidence of reliable and reproducible epidemiological dose-response data for cancer-induction at doses below 50 rad of low-LET radiation. Thus, the shape of the dose-response curve cannot be determined directly from observed human data, and "the available human data fail to suggest any specific dose-response model and are not robust enough to discriminate among *a priori* models

suggested by theoretical and experimental work." (BEIR III Report, 1980, p. 142).

It is of considerable importance to note that "[t]he [BEIR III] Committee was in general agreement that, for most radiation-induced solid cancers, the dose-response relationship for low to intermediate doses of low-LET radiation is best described by a linear-quadratic function of dose with nonnegative curvature. Nevertheless, there are arguments in favor of other models, especially the linear and the quadratic, which lead to widely divergent [risk] estimates. For these reasons, and because of the basic uncertainty associated with the choice of a single [dose-response] model, the [BEIR III] Committee decided to present an envelope of [risk] estimates bounded by the linear and the pure quadratic models, with the linear-quadratic [model] providing intermediate [risk] values." (BEIR III Report, 1980, p. 142). The scientific evidence, therefore, compels the conclusion that for low-LET radiation the risk from low-dose exposure is less than from high-dose exposure, and that the risk per unit radiation dose is less from low-dose than from high-dose levels.

Question:

Do you agree with Dr. Bross's explanation of mechanisms of radiation and chemicals causing ill-health in humans as described in response to Question 20 in his prefiled testimony?

Answer:

No. Dr. Bross by training is a statistician. His testimony overall reflects very limited understanding of biology, biophysics, genetics, medicine, and radiation biology at any level to explain the theories of mechanisms of mutagenesis and/or carcinogenesis at the cellular level and how these mechanisms manifest cancer-induction and/or genetically-related ill-health in the human. His understanding of biological mechanisms and factors of radiation and chemical carcinogenesis as indicated by his testimony is naive and confused. The problems involving both are extremely complex, highly scientific, and in large measure subject to great uncertainty.

Question:

Do you agree with Dr. Bross's assessment, expressed at page 1391 of the transcript, regarding the role of "the members of the radiation protection community" in relation to their review of his scientific articles submitted in the open literature?

Answer:

No. There are two matters here. First, Bross describes a "radiation protection community," suggesting a group of individuals with some unyielding dogma or doctrine foreign to the norm and malevolent in intention. Second, Bross describes a response to his articles that suggests deliberate and malicious intention to thwart the peer-review process and deny publication of meritorious scientific research in the open literature. Neither situation exists.

The "radiation protection community" that Bross describes does not exist. There is, however, a large number of outstanding scientists, epidemiologists, statisticians, and physicians in the radiological sciences. The most outstanding of these are asked to serve, without compensation, on the editorial boards or review committees of scholarly scientific journals in their disciplines. It is an honor to serve. Their role is to evaluate profferred scientific articles and to recommend their suitability for publication in the open scientific literature. Speed of review and publication is essential; pressure for rapid review and publication comes from the fact that the volume of profferred papers is large, and the space for publication is limited. I am unaware of any intent to maliciously deny or delay publication of Bross's or anyone else's work. Most profferred papers are ultimately published in the scientific journals because the work is meritorious. If Bross cannot get his profferred articles published in one of the very many available scientific journals in the United States, Canada and Europe, only one conclusion can be drawn: many scientists throughout the world consider Bross's profferred papers lacking in scholarship and essentially worthless, and these many scientists recommend that Bross's papers not be published in the journals they serve. It is not a conspiracy--it is the most meritorious function of the peer-review process.

Question:

Would you agree with Bross's assessment at page 1419 of the transcript that he was the only scientist at the Yale Symposium in May, 1980?

Answer:

As I understand it, Bross is a statistician. He has never been on a science faculty in a university other than for statistical support. He has never done scientific research in a biology, physics, or chemistry laboratory. He has never carried out a scientific experiment in a biology, physics, chemistry or medical laboratory. He merely helps others treat and evaluate data which the others accumulate and interpret. Statistical methods aid in the experimental scientific method, but do not substitute for it.

The Yale Symposium had a number of outstanding scientists participating who are well-recognized by their peers in the fields of physics and biology. These scientists included Professor Merrill Eisenbud, of the Institute of Environmental Medicine, New York University, School of Medicine; Professor Harold Rossi of the Department of Radiology of Columbia University College of Physicians and Surgeons; Professor Warren Sinclair of the University of Chicago School of Medicine and President of the NCRP; Professor Bernard Cohen of the University of Pittsburgh School of Public Health; Professor Rowe of Georgetown University and Director of the Institute of Risk Analysis; Professor Robert Schulz of the Department of Radiation Oncology, Yale University School of Medicine; and

Professor Jan Stowjvak of the Department of Epidemiology and Public Health, Yale University School of Medicine. I was a participant in the Yale Symposium; my scientific credentials and contributions are listed in my curriculum vitae and bibliography.

Question:

Directing your attention to page 1450 of the transcript, would a method of identifying susceptible individuals in the population prior to leukemia incidence permit the definition of a dose-response curve for leukemia?

Answer:

No. BEIR III considered the matter of sensitive subgroups with increased susceptibility to DNA damage and increased cancer risk after exposure to ionizing radiation. "The role of constitutional susceptibility to cancer induction is not well enough understood, however, for it to be used as a factor to modify risk estimates [based on dose-response relationships]. Inasmuch as the [cancer] risk estimates developed for this [BEIR III] report are averages for large populations that presumably include many genotypes, it is unlikely that these risk estimates would be notably altered if data representing very small subsets of abnormally radiosensitive persons could be recognized and excluded from the calculations. If population subsets can be identified as being at substantially greater risk of radiation carcinogenesis, their risk will require separate estimation." (BEIR III 1980 Report, p. 4).

The experience of the scientists and statisticians on the BEIR Committee (BEIR III 1980 Report), the ICRP, and the NCRP

(Report 64, 1980), is that it is unlikely that the best shapes to the dose-response curves in man can ever be resolved by statistical analysis alone, and this is particularly the case in the low-dose region below 50 rad. To the present time, analysis has to depend on attempting to estimate the risks of low-level radiation by determining how the effects of low doses are related to those higher doses. The BEIR III Report explains (p. 27, BEIR III 1980 Report) that what is needed for defining the dose-response curve in the low-dose region is a better understanding of the fundamental mechanisms by which cancers are induced by radiation. Bross's testimony demonstrates his shallow knowledge of even the most rudimentary biological processes of genetic mutagenesis and carcinogenesis.

Insofar as host factors in radiation carcinogenesis are concerned, the BEIR III Committee devoted considerable time and attention to this important area (see pp. 26-27, 141-148, 149-175 in BEIR III Report 1980). Attention and discussion was directed to initiating and promoting stages, hormonal influences, cell proliferation, immunologic surveillance and host defense mechanisms, irritant chemicals, vitamin deficiencies, viral infections, age, sex, etc. However, at no time did there arise any theory, hypothesis or scientific evidence that would support Bross's concept of "pre-existing genetic damage."

Question:

Do you agree with Bross's estimate, discussed at pages 1596 and 1598 of his transcribed testimony, that the doubling dose concept for leukemia-induction is about 5 rem and that for some individuals (with Bross's "pre-existing damage") it is substantially lower, perhaps in the range of 1 rem?

Answer:

No. The concept of "doubling-dose for cancer induction" was not used in the BEIR III 1980 Report in estimating cancer risks of exposure to low-dose, low-LET, whole-body irradiation, since the BEIR III Committee considered the concept obsolete and could not be applied to all cancers, all tissues, and all ionizing radiations. Accordingly, it chose to use risk projection models only in the above situation to estimate the cancer risk in exposed human populations.

Furthermore, Bross's risk estimates are not borne out by experience. If there is, as Bross estimates, a doubling dose of 5 rem for myeloid leukemia on the basis of diagnostic X-ray studies, and an "increased susceptibility due to pre-existing genetic damage" in individuals (as yet unrecognized) who would have a doubling dose of perhaps 1 rem, then from diagnostic X-ray experience we would expect an epidemic of myeloid leukemia due to diagnostic medical radiation in the United States and Europe, with decreasing incidence due to improved low-dose imaging procedures in modern medicine. This has not occurred. We do not have an epidemic of myeloid leukemia. We do not have a substantial change in incidence with a decreased leukemia rate resulting from improved low-dose diagnostic

imaging radiological techniques. Bross's hypothesis fails to support experience or statistics for both natural background radiation and artificial man-made radiation.

Question:

Do you agree with the criticisms cited in critiques of Dr. Bross's studies by various authors in the scientific literature and discussed by Dr. Bross during his testimony at pages 1604 through 1637 of the transcript?

Answer:

Yes. Bross invariably uses a number of techniques and procedures to alarm the public that low-level radiation is more hazardous than the majority of scientists believe it to be. While Bross lacks appropriate scientific basis for his theses, scientific experimentation, epidemiology, radiobiological theory, and other information from a myriad of scientific disciplines form the scientific bases for our present understanding of the potential hazards to health resulting in human populations exposed to low-level radiation. Bross consistently exploits spurious techniques and unconventional statistical methods to analyze selected data, introduces confounding biases, and creates unfounded hypotheses to arrive at his alarming conclusions. He remains detached from the wealth of modern scientific knowledge which continually disproves and discredits his theses and his conclusions. The findings of all his studies differ so sharply from the results of all the major studies existing that if the risks and hazards of ill-health he believes to occur were shown to result from radiation exposure

alone, then modern biology, physics and medicine would require a radical change in theories of mutagenesis, carcinogenesis, and the molecular biology of the human hereditary and constitutional structure and function.

I concur completely with the severe criticisms of Bross's studies as documented in the BEIR III 1980 Report (pp. 458-461); in NCRP Report 64, 1980 (pp. 160-162); in the Interagency (Libassi) Report 1979 (pp. 36-38); and in the critiques by Boice and Land, 1979 AJPH, by Oppenheim, by Rothman, and by Smith, Pike and Hamilton, 1973. Bross remains discredited; none of his studies is sufficiently extensive, complete, or free of serious methodologic complications to provide conclusive, or even reliable, information at the present time on the health effects of radiation at low doses.

Question:

Do you agree with Bross's description, at pages 1637 through 1651 of the transcript, of the "radiation protection community" and the expertise and qualifications Bross describes of the members of the national (e.g., NCRP and NAS-BEIR) and international (e.g., ICRP and UNSCEAR) groups and committees concerned with the sciences of radiation protection?

Answer:

No. I draw three conclusions from his statements: (1) he holds in great contempt virtually all those scientists who have dedicated their professional skills and capabilities to the understanding of radiation and health and preventive medicine--if they are or have been associated with recognized scientific bodies on a national or international level; (2) he

has concluded that a conspiracy exists, and remains a cohesive force, among perhaps 500-1000 internationally-known scientists in the fields of radiation and health, at all levels of science, in perhaps 20 nations throughout the world including the U.S.S.R, China, and the countries of Europe and the United States, that an official administrative policy was developed in the White House to agree that low-level radiation was harmless, and that the official doctrine has been supported and defended by all subscribing scientists and countries to this day; and finally, (3) he believes that a conspiracy exists to suppress all scientific evidence--by a community of designated scientific administrators--of the potential or real health effects of low-level radiation. This conspiracy he believes is now directed toward him and his peers who be believes have also demonstrated these low-dose health effects exist in a malicious attempt to discredit him so that the doctrine of the safety of low-level radiation is preserved and spread throughout the world.

It is regrettable that Dr. Bross holds such views; they simply do not square with reality.

Question:

Do you agree with Dr. Bross's claim (page 1402 of transcript) that his Yale Journal article was peer-reviewed by a group of scientific peers for quality and scientific suitability for publication in the Yale Journal of Biology and Medicine?

Answer:

No. One requirement (established by Professor Robert Schulz, the organizer of the Yale Symposium) of all the Yale Symposium participants was to submit the texts of their presentations for publication in the Yale J. Biol. Med. Thus the papers were invited for publication in the Yale Journal. I have been informed by Professor Schulz, who inquired of the Editor of the Journal to what extent these papers were reviewed prior to acceptance for publication, that all papers were briefly reviewed by a general biomedical editorial board of faculty members and students who were not necessarily experts or peers in epidemiology, biostatistics, public health, or radiation and health. Furthermore, Professor Schulz has informed me that the editorial board merely reviewed each paper for quality of writing, language, completeness, references, tables and charts, and appropriateness for the Yale Journal; the board did not necessarily review it for scientific content or scientific quality. Indeed, that editorial board accepted my paper verbatim, but it requested that I add a very few definitions of the complex radiation science abbreviations or acronyms that a broad and non-specialized readership of the Journal would not understand unless defined. I conclude, therefore, that that is not scientific peer review of my article.

On the other hand, I have been told by Professor Schulz that Bross's paper, invited for publication in the Yale Journal

as part of the Symposium, was rejected by that editorial board on first review by the board for a number of non-scientific reasons, including poor and contentious writing and language, and incompleteness of content, references, citations and tables. That editorial board did not have the expertise to judge the scientific quality of the paper. On the second or later submission by Bross, I have been told by Professor Schulz, Bross's article was accepted for publication in the Journal since he had complied with some of the requests by the board (but not all) to improve the quality of the writing and presentation. This can in no way be construed as scientific peer review of the Bross article in the Yale Journal.

Question:

Have you read the testimony of Dr. Carl Johnson which appears in the transcript of April 1, 1982, in this proceeding?

Answer:

Yes.

Question:

Directing your attention to pages 1914-16 of the transcript of Dr. Johnson's testimony, do you know whether there was controversy over the statement which appears at page 268 in BEIR III regarding synergistic effects in uranium miners who smoke?

Answer:

There was no controversy regarding that statement in the BEIR III report.

CURRICULUM VITAE

JACOB I. FABRIKANT

Birth	February 9, 1928	New York, New York

Education

1948-52	McGill University, Montreal Faculty of Arts and Science	B.Sc. (magna cum laude; Chemistry)
1952-56	McGill University, Montreal Faculty of Medicine	M.D., C.M.
1961-64	University of London, England Faculty of Science	Ph.D. (Biophysics)
1978	American College of Radiology	Fellow (F.A.C.R.)

Academic Appointments

1956-57	Duke University Hospital and School of Medicine, Durham	Intern in Surgery
1957	Duke University Hospital and School of Medicine	Assistant in Pathology
1957-58	Duke University Hospital and School of Medicine	Fellow in Surgery
1958-61	The Johns Hopkins Hospital, Baltimore	Resident in Radiology
1958-61	The Johns Hopkins University School of Medicine, Baltimore	Fellow in Radiology
1961-64	Department of Physics Institute of Cancer Research University of London, England	Advanced Fellow in Academic Radiology of the James Picker Foundation, National Academy of Sciences-National Research Council
1964-65	The Johns Hopkins University School of Medicine and School of Hygiene and Public Health, Baltimore	Advanced Fellow in Academic Radiology of the James Picker Foundation, National Academy of Sciences-National Research Council
1964-68	The Johns Hopkins University School of Medicine	Assistant Professor of Radiology
1964-70	The Johns Hopkins Hospital	Radiologist

JACOB I. FABRIKANT

Academic Appointments (cont.)

1965-68	The Johns Hopkins University School of Hygiene and Public Health	Assistant Professor of Radiological Science
1968-70	The Johns Hopkins University School of Medicine	Associate Professor of Radiology
1969-70	The Johns Hopkins University School of Hygiene and Public Health	Associate Professor of Radiological Science
1970-75	The University of Connecticut School of Medicine, Farmington	Professor and Head Department of Radiology
1973-75	The Royal Society London, England	Special Consultant for the Advisory Committee on the Biological Effects of Ionizing Radiations, National Academy of Sciences-National Research Council, U.S.A.
1973-75	Royal Postgraduate Medical School University of London, England	Picker Sabbatical Study Year James Picker Foundation National Academy of Sciences-National Research Council, U.S.A.
1973-75	Royal Postgraduate Medical School University of London, England	Visiting Colleague Department of Diagnostic Radiology
1973-75	Hammersmith Hospital Royal Postgraduate Medical School London, England	Honorary Consultant Radiologist Department of Diagnostic Radiology
1975-78	McGill University Faculty of Medicine Montreal, Canada	Professor of Diagnostic Radiology Department of Diagnostic Radiology
1975-78	The Montreal General Hospital Montreal, Canada	Diagnostic Radiologist-in-Chief Department of Diagnostic Radiology
1976-78	McGill University Faculty of Medicine	Professor & Chairman Department of Diagnostic Radiology Diagnostic Radiologist-in-Chief
1978-	University of California School of Medicine San Francisco, California	Professor of Radiology

JACOB I. FABRIKANT

Academic Appointments (cont.)

1978-80	University of California, Berkeley Donner Laboratory	Staff Scientist Research Medicine and Radiology
1979	President's Commission on the Accident at Three Mile Island, The White House, Washington, D.C.	Director, Public Health and Safety
1980-	University of California, Berkeley Lawrence Berkeley Laboratory	Staff Senior Scientist

JACOB I. FABRIKANT

Academic and Professional Organizations

American College of Radiology, 1972-; Member, 1972-78; Fellow, 1978-
Society of Chairmen of Academic Radiology Departments, 1970-75, 1976-78
Association of University Radiologists, 1967-
British Institute of Radiology, 1961-
Society of Nuclear Medicine, The Academic Council, 1970-
Canadian Association of Radiologists, 1975-80; Committee on Basic Research 1975-78
The New England Roentgen Ray Society, 1972-78
Radiological Society of Connecticut, 1971-75
Association for Radiation Research (U.K.), 1964-
Radiation Research Society, 1965-; Councillor in Medicine, 1973-76
Sigma Xi, 1971-
Cell Kinetics Society, 1978-
Connecticut State Medical Society, 1971-75
The Johns Hopkins Medical and Surgical Association, 1965-
Maryland Medical and Chirurgical Society, 1958-70
American Association for the Advancement of Science, 1966-75
American Institute of Biological Sciences, 1968-75
Alpha Omega Alpha, 1955-
Nu Sigma Nu Medical Fraternity, 1953-

Academic Honors

Alpha Omega Alpha Honorary Medical Society, McGill University Faculty of Medicine, Montreal, 1955-
Wood Gold Medal, McGill University Faculty of Medicine, Montreal, 1956
Advanced Fellow in Academic Radiology of the James Picker Foundation, National Academy of Sciences-National Research Council, 1961-65
Special Consultant, Committee on the Biological Effects of Ionizing Radiations, National Academy of Sciences-National Research Council, The Royal Society, London, England, 1973-75
Picker Sabbatical Study Year Award of the James Picker Foundation, National Academy of Sciences-National Research Council, 1973-75
Visiting Colleague in Diagnostic Radiology, Royal Postgraduate Medical School, England, 1973-75
Fellow of the American College of Radiology (F.A.C.R.), 1978

Visiting Professorships

Visiting Professor of Radiology, Bowman Gray School of Medicine, 1968
Visiting Professor of Oncology, Clinical Cancer Program, Georgetwon University School of Medicine and Hospital, 1969
Visiting Radiation Biologist, American Institute of Biological Sciences, 1969-75
William O'Brien Professor of Radiation Science, University of Minnesota School of Medicine and Hospitals, 1970

Visiting Professorships (Continued)

Visiting Professor of Radiology, University of Vermont College of Medicine, 1970, 1977-78
Visiting Scientist, Gray Laboratory, Cancer Research Campaign, Mt. Vernon Hospital, England, 1971
Visiting Lecturer, Cambridge University Medical School, Addenbrooke's Hospital, England, 1971
Visiting Professor of Radiology, University of Southern Florida College of Medicine, 1973
Visiting Professor of Radiology, University of Montreal, Faculty of Medicine, Montreal, 1977
Visiting Lecturer, Oxford University Medical School, The Radcliffe Infirmary, Oxford, England, 1979
Visiting Lecturer, University of London, Institute of Cancer Research, London, England, 1979
Visiting Professor of Radiation Medicine, Brown University, 1979

Scientific Advisory Committees

Commission on Radiation and Infection, Armed Forces Epidemiological Board, Liaison Member, 1965-66
Committee on Radiology, Division of Medical Sciences, National Academy of Sciences-National Research Council, Member, 1967-74
X-Ray Image Production and Related Facilities Advisory Committee, DHEW, USPHS, Member, 1968-69
Medical Radiation Advisory Committee, Bureau of Radiological Health, DHEW, USPHS, Member, 1969-74
Long-Term Radiation Effects Advisory Committee, DHEW, USPHS, Member, 1969-74
Neurology A Study Section, National Institutes of Health, DHEW, Member, 1969-72
Committee on the Biological Effects of Ionizing Radiations, National Academy of Sciences-National Research Council, Member, 1973-;
Vice-Chairman, 1973-77;
Subcommittee on Medical Radiation, Member, 1973-77
Subcommittee on Somatic Effects, Member, 1977-
Ad hoc Subcommittee on Somatic Effects, Chairman, 1979-
Committee on Genetic and Carcinogenic Effects, Division of Radiotherapeutic Research, Commission on Radiation Therapy, American College of Radiology, Member, 1972-76
Committee on Medical Uses of Radiation and the Radiation Exposure of Patients, National Radiological Protection Board, United Kingdom, Member, 1974-75
Associate Committee on Scientific Criteria for Environmental Quality, Subcommittee on Physical Energy, National Research Council, Canada, Member, 1976-78
Committee on Radiation Risks to Space Workers (Space Powered Satellite), National Aeronautics Space Administration, Member, 1979-
Committee on Federal Research into the Biological Effects of Ionizing Radiation, National Institutes of Health, DHEW, Member, 1979-
President's Commission on the Accident at Three Mile Island, The White House, Washington, D.C.; Director, Public Health and Safety, 1979
International Commission on Radiological Protection, Committee 1 on Radiation Effects, Member, 1980-

JACOB I. FABRIKANT

Extramural Research and Education Review Committees

National Academy of Sciences-National Research Council, Committee on Radiology, Division of Medical Sciences, Member, 1967-74
U.S. Atomic Energy Commission, Division of Biology and Medicine, Consultant, 1968-75
National Science Foundation, Division of Developmental Biology, Consultant, 1970
State of Connecticut, Commission on Higher Education, Standing Committee on Accreditation, Connecticut Council on Higher Education, Consultant, 1971-73
Connecticut Cancer Epidemiological Program, Planning Committee, Secretary, 1972-73
American Cancer Society, Connecticut Division, Board of Directors, Member, 1972-73
National Academy of Sciences-National Research Council Assembly of Life Sciences, Division of Medical Sciences, Consultant, 1972-75
U.S. Energy Research and Development Agency, Consultant, 1975-76
McGill University, University Senate
Senator, 1976-78
McGill University, Faculty of Graduate Studies and Research, Faculty Council, The Graduate Council, Councillor, 1975-78
McGill University, Faculty of Medicine, Postgraduate Training Committee, Member, 1975-78
McGill University Faculty of Medicine, Department of Diagnostic Radiology, Postgraduate Training Committee, Program Director, 1976-78

Scientific Journal Review

Cell and Tissue Kinetics, 1968-; Member, Editorial Board, 1972-
Investigative Radiology, 1973-; Member, Editorial Board, 1973-76
Journal of the Canadian Association of Radiologists, 1976-; Member, Editorial Board, 1976-78
McGill Medical Journal, 1952-56; Managing Editor, 1954-55; Editor, 1955-56
Cancer Research, 1968-
Journal of the National Cancer Institute, 1969-
Biology of Reproduction, 1970-
Radiology, 1970-
Science, 1970-
Medicine, 1970-
BioScience, 1970-
Cancer, 1971-
Radiation Research, 1972-
International Journal of Applied Radiation and Isotopes, 1973-

Hospital Appointments

1964-70	The Johns Hopkins Hospital Baltimore, Maryland	Radiologist
1970-73	University of Connecticut Hospital Hartford, Connecticut	Head, Department of Radiology
1973-75	University of Connecticut Hospital Hartford, Connecticut	Attending Radiologist
1970-73	Veterans Administration Hospital Newington, Connecticut	Acting Chief, Department of Radiology; Consultant in Radiology
1971-75	New Britain General Hospital New Britain, Connecticut	Consultant in Radiology
1971-75	William W. Backus Hospital Norwich, Connecticut	Consultant in Radiology
1972-75	Hartford Hospital Hartford, Connecticut	Consultant in Radiology
1972-75	Mount Sinai Hospital Hartford, Connecticut	Consultant in Radiology
1973-75	Hammersmith Hospital London, England	Honorary Consultant Radiologist Department of Diagnostic Radiology
1975-78	The Montreal General Hospital Montreal, Canada	Diagnostic Radiologist-in-Chief Department of Diagnostic Radiology
1975-78	The Montreal General Hospital Montreal, Canada	Director, Department of Diagnostic Radiology
1978-present	Cowell Memorial Hospital University of California, Berkeley	Physician
1978-present	University of California Medical Center, San Francisco	Radiologist, Clinical Faculty

JACOB I. FABRIKANT

Certification

1962 American Board of Radiology

Medical Licensure

1957 National Board of Medical Examiners (No. 36999)
1958 Maryland (No. D 1511)
1971 Connecticut (No. 14808)
1973-75 Great Britain
1976-78 Quebec, Canada (No. 76-033)
1978 California (No. G 36656)

Military Service

World War II, Veteran, United States Navy

Marital Status

Irene B. Fabrikant, Wife

B.Sc. (McGill University)
M.Sc. (McGill University, Bacteriology and Immunology)
Ph.D. (University of Maryland, Microbiology)

1966-70 Instructor, Department of Microbiology
University of Maryland School of Medicine
1970-75 Assistant Professor of Medicine, Department of Medicine
The University of Connecticut School of Medicine
1973-75 Honorary Research Fellow (Immunology)
Department of Zoology and Comparative Anatomy
University College, London, England
1975-78 Assistant Professor, Department of Microbiology & Immunology
Faculty of Medicine, McGill University, Montreal
1977-78 Executive Secretary, McGill University Biohazards Committee
McGill University, Montreal
1978-79 Research Fellow, U.S. Public Health Service, DHEW
Center for Disease Control, San Juan Laboratories, Puerto Rico
1979- Research Associate, University of California, Berkeley, School of Public Health, Department of Biomedical & Environmental Health Sciences

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2. Fabrikant, J.I. The Dean. (Editorial) McGill Med. J. 24:180, 1955.

3. Fabrikant, J.I. A concept of the term "anxiety". McGill Med. J. 24:201-207, 1955.

4. Fabrikant, J.I. Pediatric problems in clinical practic. (Book Review) McGill Med. J. 24:114-115, 1955.

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6. Anylan, W.G., Baylin, G.J., Fabrikant, J.I. and Trumbo, R.B. Studies in coronary angiography. Surgery 45:8-18, 1959.

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9. Fabrikant, J.I. Reflections on illness. Il. Quart. 3:6-8, 1959.

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14. Fabrikant, J.I. The wet colostomy. Il. Quart. 4:1-5, 1959.

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16. Fabrikant, J.I., Anlyan, W.G. and Creadick, R.N. Management of intestinal injuries caused by pelvic irradiation. Modern Med. 28:117-118, 1960.

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24. Koehler, P.R., Fabrikant, J.I. and Dickson, R.J. Observations on the behavior of testicular tumors with comments on racial incidence. J. Urol. 87: 577-579, 1962.

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28. Fabrikant, J.I. Cellular response and cell population kinetics under continuous irradiation. Radiologic changes in bone following irradiation. (In) James Picker Foundation, Annual Report, pp. 23-25, New York, 1962.

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32. Fabrikant, J.I. Regenerating liver. (In) Report of the Institute of Cancer Research: Royal Cancer Hospital, Annual Report, p. 122, London, 1963.

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52. Fabrikant, J.I. Radiation sterilization in man. JAMA 200:201-202, 1967.

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62. Fabrikant, J.I. The analysis of cell population kinetics in a conditional renewal system under continuous irradiation. (In) Russell H. Morgan, A Tribute. Eds., Fabrikant, J.I. and Donner, M.W., pp. 93-100, du Pont, Wilmington, Delaware, 1967.

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75. Fabrikant, J.I. Cell proliferation in the regenerating liver of continuously irradiated mice; effect of a radiation-free interval. Brit. J. Radiol., 41:369-374, 1968.

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77. Hoopes, J.E. and Fabrikant, J.I. Objective evaluation of cleft palate speech. Plast. Reconstr. Surg., 42:214-224, 1968.

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81. Fabrikant, J.I., Wisseman, C.L., III, and Vitak, M.J. The kinetics of cellular proliferation in normal and malignant tissues. II. An in vitro method for incorporation of tritiated thymidine in human tissues. Radiology 92:1309-1320, 1969.

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83. Fabrikant, J.I. and Cherry, J. The kinetics of cellular proliferation in normal and malignant tissues. III. Cell proliferation in the larynx. Ann. Otol., Rhinol., Laryngol., 78:326-341, 1969.

84. Hoopes, J.E., Dellon, A.L., Fabrikant, J.I. and Soliman, H. The locus of levator veli palatini function as a measure of velopharyngeal incompetence. Plastic Reconstr. Surg., 44:155-160, 1969.

85. Fabrikant, J.I. and Foster, B.R. The kinetics of lymphoid cell proliferation during radiation lymphomogenesis in C57BL mice. Radiation Res., 39:544, 1969.

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87. Fabrikant, J.I. Size of proliferating pools in regenerating liver. Exp. Cell Res., 55:277-279, 1969.

88. Fabrikant, J.I. Radiation response in relation to the cell cycle in vivo. Amer. J. Roentgenol., Rad. Therapy and Nuclear Med. 105:734-745, 1969.

89. Fabrikant, J.I. Studies on cell population kinetics in radiation leukemogenesis. Assn. Univ. Radiologists 17:88, 1969.

90. Fabrikant, J.I. and Foster, B.R. Cell cycle of lymphocytes in mouse thymus. Die Naturwissenschaften 57:567, 1969.

91. Fabrikant, J.I. Cell proliferation in continuously irradiated mammals; Effect of age. (In) Radiation Biology of the Fetal and Juvenile Mammal, Sikov, M. and Mahlum, D.D., eds. USAEC, CONF. 690501, pp. 621-628, Oak Ridge, Tenn., 1969.

92. Hoopes, J.E., Dellon, A.L., Fabrikant, J.I., Edgerton, M.T. and Soliman, A.H. Cineradiographic definition of the functional anatomy and pathophysiology of the velopharynx. (ab) Intern. Congr. Cleft Palate, 42, Houston, Texas, 1969.

93. Fabrikant, J.I. The kinetics of cellular proliferation in the seminiferous epithelium under continuous irradiation. XII Intern. Congr. Radiology 12:98, 1969.

94. Fabrikant, J.I. Radiation effects on lymphopoiesis under continuous low dose-rate exposure. Radiology 93:887-893, 1969.

95. Hoopes, J.E. and Fabrikant, J.I. Objective evaluation of cleft palate speech. (ab) Cleft Palate J. 6:181, 1969.

96. Fabrikant, J.I. Research on cell proliferation in normal and malignant human tissues. (In) James Picker Foundation Annual Report, 1968, pp. 45-50, 1969.

97. Fabrikant, J.I. The kinetics of cellular proliferation in normal and malignant tissues. VIII. Studies on cell population kinetics in normal, inflammatory and neoplastic tissues in man. (ab) XII Intern. Congr. Radiology 12:442, 1969.

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99. Fabrikant, J.I. and Wisseman, C.L., III. In vitro incorporation of tritiated thymidine in normal and neoplastic tissues. (In) Year Book of Radiology, Holt, J.F., Whitehouse, W.M. and Latourette, H.B., eds., pp. 383-384, Year Book Medical, Chicago, 1969.

100. Fabrikant, J.I. The kinetics of cellular proliferation in human tissues. IX. Estimation of DNA synthesis time in normal and malignant tissues. (ab) Radiol. Soc. N. Amer. 55:44, 1969.

101. Fabrikant, J.I. Tumor cell population kinetics during radiation lymphomogenesis. (ab) Radiol. Soc. N. Amer. 55:124, 1969.

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103. Fabrikant, J.I. and Kovar, D.S. Spermatogonial cell renewal under continuous irradiation at 1.8 rads/day. (ab) Radiation Res. 18:233, 1970.

104. Dannenberg, A.M., Jr., Shima, K., Chandrasekhar, S. and Fabrikant, J.I. Macrophage proliferation, maturation, and function in rabbit BCG lesions. (ab) Fed. Proc. 29:501, 1970.

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108. Fabrikant, J.I. The kinetics of cellular proliferation in normal and malignant tissues. IV. Nucleic acid synthesis in human tissues. (ab) Invest. Radiol. 5:281, 1970.

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112. Fabrikant, J.I. Report of the United Nations Scientific Committee on the Effects of Atomic Radiation. Supplement 13, 1969. (Book Review) Social Biol. 17:238-241, 1970.

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117. Fabrikant, J.I. Effects of rapidly and slowly proliferating cell renewal systems. Sixth Annual San Francisco Cancer Symposium, (ab) 5:26, 1970.

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JACOB I. FABRIKANT

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April 20, 1982

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

CERTIFICATE OF SERVICE

I hereby certify that copies of the following listed documents were served upon the parties identified on the attached Service List by Express Mail, except those parties designated by a single asterisk (*) were served by hand delivery and those parties designated by a double asterisk (**) were served by deposit in the United States mail, first class, postage prepaid, this 20th day of April, 1982.

(1) Applicant's Testimony of Robert G. Azzarello, Alexis Tsaggaris, and Ronald J. Perry on Radiological Emergency Response Plans, Contentions 17/26 (1)(a), (c), (d), (e) and (f).

(2) Applicant's Testimony of Kevin P. Twine on Radiological Emergency Response Plans, Contention 17/26(1)(b).

(3) Testimony of John M. Lucas on Radiological Emergency Response Plans.

(4) Testimony of Bertram Paul Madere on Radiological Emergency Response Plans.

(5) Testimony of Robert William Myers on Radiological Emergency Response Plans.

(6) Applicant's Testimony of John J. Mauro on the Use of Potassium Iodide as a Thyroid Blocking Agent.

(7) Applicant's Rebuttal Testimony of George B. Hutchison on Contention 8/9.

(8) Applicant's Rebuttal Testimony of Jacob I. Fabrikant on Contention 8/9.

(9) Applicant Exhibit No. 6. Wallace Laboratories Patient Package Insert for Thyro-Block (Potassium Iodide).

(10) Applicant Exhibit No. 7. Department of Health, Education, and Welfare (Food and Drug Administration) Notice, Request for Submissions of New Drug Applications, Potassium Iodide as a Thyroid-Blocking Agent in a Radiation Emergency. 43 Fed. Reg. 58,798 (Dec. 15, 1978).

(11) Applicant Exhibit No. 8. Memorandum dated March 26, 1981 to William J. Dircks, NRC Executive Director for Operations, from Samuel J. Chilk, NRC Secretary, with attachments.

Bruce W. Churchill

Dated: April 20, 1982

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

Before the Atomic Safety and Licensing Board

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

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