UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	DOCKET NOS. 50-295
COMMONWEALTH EDISON COMPANY	)	50-304
(Zion Station Units 1 & 2)	)	

SPENT FUEL RERACKING

TESTIMONY OF,

GREGORY C. MINOR,
on behalf of the
STATE OF ILLINOIS
Office of the Attorney General

DATED: May 22, 1979

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TESTIMONY OF GREGORY C. MINOR concerning contentions 2(e), 2(f), 2(h), 2(j) and 4(a).

My name is Gregory C. Minor and I am a partner in MHB Technical Associates in San Jose, California. I have had nineteen (19) years experience in the nuclear industry, including design, maintenance and checkout of nuclear reactor systems, design and testing of safety and control systems for use in nuclear reactors, and the performance of safety analyses for various local, state and national organizati A statement of my background and qualifications is attached to this testimony as attachment I.

The following testimony concerns the proposed modification of the spent fuel pool at the Commonwealth Edison Station at Zion, Illinois. This testimony pertains to contentions 2(e), 2(h), 2(j), 2(f) and 4(a) as described in the Board's Order Following Prehearing Conference, January 19, 1979, and will demonstrate that the proposed modification application does not deal with numerous unresolved technical problems and that many essential procedures are yet to be developed by the Applicant. The testimony will first address those contentions which have not resolved problems of corrosion and degradatic of the Boaral: 2(e), 2(h) and 2(j). Accident scenarios and effects, including sabotage, will be addressed in the testimony on 2(f) and Board question 4(a).

TESTIMONY OF GREGORY C. MINOR concerning contentions 2(e), 2(f), 2(h), 2(j) and 4(a).

My name is Gregory C. Minor and I am a partner in MHB Technical Associates in San Jose, California. I have had nineteen (19) years experience in the nuclear industry, including design, maintenance and checkout of nuclear reactor systems, design and testing of safety and control systems for use in nuclear reactors, and the performance of safety analyses for various local, state and national organizati A statement of my background and qualifications is attached to this testimony as attachment I.

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STATEMENT OF CONTENTION

2(e) The amendment request and supporting documentation do not adequately discuss monitoring procedures. In the light of the proposed modification and long term storage of nuclear spent fuel the applicant should clarify the following:

(3) Methods for detecting the loss of neutron absorber material and/or swelling of stainless steel tubes in storage racks.

(4) Details of a corrosion test program to monitor performance of materials used in construction of the racks.

DISCUSSION

1. The Applicant has described a general plan for verifying the presence and adequacy of the neutron absorber by QA inspections during construction, by conducting neutron absorption tests after installation[1], and by a coupon test during the life of the pool[2]. However, the details of how this plan will be carried out are not clear at this time. Nuclear Regulatory Commission Criteria for overseeing surveillance are also not clearly developed[3]. The procedures to be utilized by the Commonwealth Edison staff for reviewing the racks, for installing the racks or for inspecting the racks in the Zion pool have yet to be written[4]. It is therefore

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[1] CECO response to NRC Second Round of Questions 1/24/79 page 4.1

[2] ibid.

[3] Deposition of Frank Almeter, May 18, 1979, page 47.

[4] Deposition of Walter Shewski, May 19, 1979, pages 22-24

impossible for the NRC staff to properly evaluate the surveillance and inspection programs which have been proposed.

A plan has been described to test the tubes prior to placement of spent fuel. A neutron source will be inserted into each tube and measured with sensors to determine the neutron attenuation of the tube and the Boral. There appears to be no plan to measure the condition of the absorbing materials in the racks after spent fuel has been placed in the cells.[5] Visual inspection would be unsatisfactory for all but the cells on the edge racks next to the walls.

The plan for In-service Inspection (ISI) is to suspend a number of Boral and stainless steel sample vented coupons in the pool as an indicators of the degradation of the materials used in constructing the borals racks. Periodically, some of these coupons will be removed and tested. The test will involve only a few samples and may be misleading unless the samples experience the worst-case corrosion environment in the racks. Presently, the Applicant has not defined the specific criteria by which it will evaluate the coupon tests.

In 1978 swelling in Boral racks was detected in the spent fuel pools at Monticello and Brown's Ferry Unit No. 3. The swollen racks utilized a sealed cell designed by General Electric Company.

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[5] Ibid. page 46

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Leaks in the welds allowed water to enter the cells and facilitate corrosion of the aluminum plates of the Boral. Hydrogen gas generated by the corrosion caused bulging of the thin shroud on the cell. To resolve the problem vents were drilled on the top of each swollen cell in order to release the trapped gas and reduce the swelling. Commonwealth Edison, aware of these incidents, has decided to prevent this known cause of swelling by starting with a vented design for the Zion racks. The penalty for this decision is the fact that some corrosion will occur in all cells over the life of the plant.

Brooks & Perkins report No. 578, dated July 7, 1978 is cited as the justification for venting the cells of the Zion dense storage racks[6]. This report cites the general corrosion of aluminum as 0.16 mils per year (or 6 mils over a 40 year period); galvanic corrosion rates of 0.1 mils/year (4 mils over 40 years); pitting depths of up to 5 mils in only 1/3 year and the generation of substantial gas pressure due to radiolytic decomposition of borated water in a Boral matrix exposed to a high neutron flux for a short time. Each of these conditions is marginally acceptable for the 10 mil Aluminum clad under the proposed pool environment but they leave no margin for possible combined effects, unknowns and uncertainty. Commonwealth Edison evidence involves research and tests of only 1-2 year periods and there has been no experience with vented cells over a 40 year lifetime.

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[6] CECO response to NRC second round of questions 1/24/79 page 2.1

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[6] CECO response to NRC second round of questions 1/24/79 page 2.1

Note, none of the conditions listed in the Brooks and Perkins report would be expected to occur in a non-vented tube or cell, provided that a water tight seal could be maintained over the projected 40 year life of the racks.

STATEMENT OF CONTENTIONS

2(h) The amendment request and supporting documentation have not analyzed the long term (including storage during the operating lifetime of the reactor) electrolytic corrosion effects of using dissimilar alloys for the pool liners, pipes, storage racks and storage rack bases, such as the galvanic corrosion between unanodized aluminum as is used in Brooks and Oerkins storage racks, and the stainless steel pool liner.

2(j) The amendment request and supporting documentation do not give sufficient data to fully assess the durability and performance of the Boral-stainless stell tubes which form the spent fuel storage racks.

(1) there is inadequate analysis of the corrosion rate of the tubes.

(2) there is no calculation of the effect of water chemistry on the Boral within the stainless steel.

(3) there is no mention of the possible swelling of Boral within the stainless steel tubes, a condition which could affect, among other things, removal of fuel assemblies from the racks.

DISCUSSION

There has been very little actual operating experience with Boral/stainless steel racks in a dense storage pool configuration. The effects of using vented Boral racks are even less known. It is generally agreed that if pool water is allowed to enter the tubes electrolytic corrosion will occur between the aluminum cladding

on the Boral and the stainless steel shroud. Thus the decision to vent, insures that water will enter rack tubes and will permit electrolytic corrosion. The long term effect of this corrosion is not certain. So far, tests that have been done are short term tests on a small number of samples. The results of these tests, which are nominally one year long, are being extrapolated to 40 years in order to attempt to determine the impact over the lifetime of the racks.

Brooks and Perkins and Leckenby, the fabricators of the Boral and racks which are to be used at Zion are also manufacturing racks for dense storage of spent fuel at the Salem reactor also in New Jersey. However, at Salem a decision was made to seal the tubes (a non-vented design) because of the uncertainty of possible long term effects of corrosion in a vented tube. One of the Exxon researchers stated the reasons for utilizing the sealed tube as follows:

> "...one you have vented every storage cell its too late, you can never go backwards and that's what you're looking at. You don't know the consequences of 30 or 40 year Boral performance in a specific pool environment. If you have any storage cell vented, you don't go backwards. The consequences of that if something unexpected should happen, in our judgment, is much more severe than the nuisance factor of a random--which we don't expect--having to vent a fuel assembly, a storage cell with a fuel assembly in it."[7]

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[7] Testimony of Thomas Eckhardt, spokesman for Exxon, designer of the Salem racks In the Matter of Public Service E & G Co. (Salem Station, Unit No. 1), Docket No. 50-272, Hearings before the ASLB May 4, 1979, Salem N.J. at 767.

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The structural strength of the Boral plate is derived from the binder and the 10 mil Aluminum cladding. There are two possible failure modes of these plates that have not been addressed and warrant further attention - particularly in a vented cell. One is the gradual delamination of the clad due to a weak bond during manufacturing. The second is the corrosion of the binder after pitting or leakage has worked its way through the 0.010 inch clad. Borated water in this region under the influence of a neutron flux has been analyzed to cause slow gas build-up due to radiolysis of the water.[8]

In his affidavit, previously submitted[9], Mr. Frank Almeter identified corrosion rates of such a magnitude that if projected over the 40 year pool life, the entire 0.010 inch thickness of the clad could be corroded. If that were to occur it could expose areas of the Boral matrix of B_4C and its aluminum binder. This would allow corrosion to occur on the binder itself and threaten the integrity of the Boral plate. Mr. Almeter is now referring to early 1950's research[10] which gives lower values for corrosion, but may not be as applicable to Boral as the later tests cited in the affidavit (Exxon and North Carolina-Virginias).

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[8] Brooks and Perkins Reports 572-
EXPERIMENTAL OBSERVATION OF BORAL PLATES ENCASED IN STAINLESS STEEL UNDER THE INFLUENCE OF GAMMA AND NEUTRON FLUXES, FEB. 1976.

[9] Almeter affidavit in support of NRC Staff Motion for Summary Disposition pages 5 & 6 of Contentions file.

[10] Article by DRALEY, 1956; See Almeter deposition 5/18/79, page 28.

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Anodizing the Aluminum surface in the Boral plate would reduce the amount and rate of corrosion of the surface. However, this alternative design approach has not been addressed in the application on supporting documents.

STATEMENT OF CONTENTION

2(f)(1) There is insufficient documentation to establish the methods by which the Applicant will positively prevent the movement of heavy objects, such as shipping casks or empty fuel racks, over the pool during modification; thus accidental droppings of such heavy objects, which could lead to unacceptable damage to spent fuel or the pool liner and consequent release of radio-nuclides, has not been precluded.

(f)(2) There is insufficient information regarding the methods by which accidental damage to stored fuel assemblies will be prevented during the installation of the new poisoned spent fuel storage racks.

DISCUSSION

Normal pool operating procedures restrict moving heavy objects over the soent fuel pool. During the rack modification it will be necessary to move the new racks (the larger ones estimated to weigh over 15 tons) over the pool using the largest bridge crane. This will require defeating the normal interlocaks. Since there is spent fuel in the pool (about 350 fuel bundles) the movement of the heavy racks over the pool could result in damage to the fuel if a rack is dropped. Although it is a low probability event, nonetheless it deserves at least a review. This has not been analyzed in the SER or Application.

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STATEMENT OF BOARD QUESTION

4(a)(3) The Licensing Board propounds the following questions to each of the parties, with the request that evidentiary showings on each of the questions be made at the forthcoming public hearing in this case:

(a) Will the proposed modifications of the spent fuel pool and/or the operation of the Zion station with increased spent fuel pool storage capacity:

(3) increase the potential risk of industrial sabotage to the Station or to the special nuclear material?

DISCUSSION

The risk due to sabotage may be treated as the product of the probability of sabotage and the consequences of a successful sabotage attempt (Wash 1400 definition of risk).

The applicants documentation provided with the application has not shown an increase in security or sabotage prevention over that utilized in the previous pool rack configuration. Security documents were not made available to the intervenors during discovery therefore it is not possible to constructively comment on changes to the plan which might be made necessary by the proposed modification. It should be borne in mind, however, that the modification has already attracted a great deal of public concern. Demonstrations have been held at the Zion Station as recently as May 12, 1979, to protest the licensing of additional spent fuel storage. If such attention continues sabotage may become a more likely event. The additional amounts of radioactive material to be stored in the spent fuel pool will make the effect of any successful sabotage incident involving the pool that much more hazardous. The new racks will contain over 10 core loads (over 2000

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bundles) spent reactors fuels from Zion units 1 & 2; some may be extra high burnup fuel as a result of planned experiments. The pool will therefore contain almost 3 times the inventory of the high level wastes and the actinides with longer half lives, but not an appreciably larger quantity of short-lived gases and fission by-products.

Assuming that the probability for sabotage succeeding in releasing the radioactive by products contained within the spent fuel remains the same as previously analyzed, (e.g. FSAR) the amount of radiation which could possibly be released is considerably greater. In the event that a greater quantity of radioactivity is released to the environment through a sabotage event, the potential consequences and, therefore, the risks are increased.

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I have prepared and read the foregoing testimony and swear that it is true and accurate to the best of my knowledge.

Gregory C. Minor

Gregory C. Minor

Subscribed and sworn to before me this 23rd day of May 1979.

Jane M. Shears

NOTARY PUBLIC

My commission expires

EXHIBIT I

RESUME

Gregory C. Minor
366 California Avenue, Suite 7
Palo Alto, CA 94306
(415)329-0474

EXPERIENCE

1976 - Present

- MHB Technical Associates, Palo Alto, California. Engineering and Energy consultant to numerous state, federal and private organizations. Major activities include studies of safety and risk involved in energy generation, providing technical consulting and expert witness to legislative, regulatory, public and private groups. Recently completed co-editing a critique of the Reactor Safety Study (WASH-1400) for the Union of Concerned Scientists and a major risk analysis for the Swedish Energy Commission.

1972 - 1976

Manager - Advanced Control and Instrumentation Engineering, General Electric Company, Nuclear Energy Division, San Jose, California.

Managed a design and development group of thirty engineers, two clerical and two technicians in designing systems for use in the measurement, control and operation of nuclear reactors. Involved coordination with other reactor design organizations, the Nuclear Regulatory Commission and customers, both overseas and domestic.

Responsibilities included coordinating and managing the technical control systems, safety systems and new control concepts for use on the next generation of reactors. The position included responsibility for standards applicable to control and instrumentation, as well as the design of short-term solutions to field problems. The disciplines involved included electrical and mechanical engineering, seismic design and process computer control/programming.

1970 - 1972

Manager - Reactor Control Systems Design - General Electric Company, Nuclear Energy Division, San Jose, California.

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1963 - 1970

Design Engineer - General Electric Company, Nuclear Energy Division, San Jose, California.

Responsible for the design of specific control and instrumentation systems for nuclear reactors. Lead design responsibility for various subsystems of instrumentation used to measure neutron flux in the reactor during startup and intermediate phase. Performed lead system design function in the design of a major system for measuring the power generated in nuclear reactors. Other responsibilities included on-site check out and testing of a complete reactor control system at an experimental reactor in the South West. Received patent for Nuclear Power Monitoring System.

1960 - 1963

Advanced Engineering Program - General Electric Company, Assignments in Washington, California and Arizona.

Rotating assignments in a variety of disciplines:

- Reactor maintenance and instrument design, engineer, KE and D reactors, Hanford, Washington. Circuit design and equipment maintenance coordination.

- Design Engineer - Microwave Department, Palo Alto, California. Work on design of cavity couplers for TWT's.

- Design Engineer - Computer Department, Phoenix, Arizona. Design of core driving circuitry.

- Design Engineer - Atomic Power Equipment Department, San Jose, California. Circuit design and analysis.

- Design Engineer - Space Systems Department, Santa Barbara, California. Prepare control portion of satellite proposal.

- Technical Staff - Technical Military Planning Operation. (TEMPO), Santa Barbara, California. Prepare analysis of missile exchanges.

During this period, completed three-year General Electric program of extensive education in advanced engineering principles of higher mathematics, probability and analysis. Also completed courses in Kepner-Tregoe, Effective Presentation, Management Training Program and various technical seminars.

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EDUCATION

University of California at Berkeley, BSEE, 1960.

Advanced Course in Engineering - 3-year Curriculum, General Electric Company, 1963

Stanford University, MSEE, 1966.

HONORS AND ASSOCIATIONS

- Tau Beta Pi Engineering Honorary Society
- Co-holder of U.S. Patent No. 3,565,760, "Nuclear Reactor Power Monitoring System", February 1971.
- Member: American Association for Advancement of Science.
- Member: Nuclear Power Plant Standards Committee, Instrument Society of America.

PERSONAL DATA

Born: June 7, 1937
Married, three children
Height: 5'8", Weight: 165 lbs.
Health: Excellent

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University of California at Berkeley, BSEE, 1960.

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PUBLICATIONS AND TESTIMONY

1. Testimony by G.C. Minor, D.G. Bridenbaugh, and R.B. Hubbard before the Atomic Safety and Licensing Board, Sep. 25, 1978, In the Matter of the Black Fox Nuclear Power Station Construction Permit hearings, Tulsa, Oklahoma.

2. Presentation by G.C. Minor before the Federal Ministry for Research and Technology (BMFT), Meeting on Reactor Safety Research, Man/Machine Interface in Nuclear Reactors, August 31 and September 1, 1978, Bonn Germany.

3. Testimony by G. C. Minor before the California Legislature Assembly Committee on Resources, Land Use and Energy, AB 3108, April 26, 1978, Sacramento, California.

4. Testimony by G. C. Minor before Wisconsin Public Service Commission, February 13, 1978, subject: Loss of Coolant Accidents: Their Probability and Consequence.

5. Swedish Reactor Safety Study: Barsebäck Risk Assessment, MTB Technical Associates, January 1978. (Published by Swedish Department of Industry as Document DsI 1978:1)

6. The Risks of Nuclear Power Reactors: A Review of the NRC Reactor Safety Study WASH-1400 (NUREG-75/014), H. Kendall, et al, edited by G. C. Minor and R. B. Hubbard for the Union of Concerned Scientists, August 1977.

7. Testimony of G. C. Minor before the Cluff Lake Board of Inquiry, Regina, Saskatchewan, Canada, September 21, 1977.

8. Testimony of G. C. Minor regarding the Grafenrheinfeld Nuclear Plant, March 16-17, 1977, Wurzburg, Germany.

9. Testimony of G. G. Minor and R. B. Hubbard before California State Senate Committee on Public Utilities, Transit, and Energy March 23, 1976.

10. Testimony of D. G. Bridenbaugh, R. B. Hubbard, G. C. Minor to the California State Assembly Committee on Resources, Land Use, and Energy, March 8, 1976.

11. Testimony of D. G. Bridenbaugh, R. B. Hubbard, G. C. Minor before the Joint Committee on Atomic Energy, hearings held February 18, 1976, and published by Union of Concerned Scientists, Cambridge, Massachusetts.

PUBLICATIONS AND TESTIMONY

12. G.C. Minor, W.G. Milam, "An Integrated Control Room System for a Nuclear Power Plant", NEDO-10658, presented at International Nuclear Industries Fair and Technical Meetings, October 1972, Basle, Switzerland.

13. The above article was also published in the German Technical Magazine, NT, March 1973.

14. G. C. Minor, S.E. Moore, "Control Rod Signal Multiplexing," IEEE Transactions on Nuclear Science, Vol. NS-19, February 1972.

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12. G.C. Minor, W.G. Milam, "An Integrated Control Room System for a Nuclear Power Plant", NEDO-10658, presented at International Nuclear Industries Fair and Technical Meetings, October 1972, Basle, Switzerland.

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(Zion Station Units 1 & 2)	)	50-304

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing TESTIMONY on behalf of the State of Illinois dated May 29, 1979 in the above-captioned matter have been served upon the following by deposit, first class, in the United States Mail, this 29th day of May, 1979.

Edward Luton, Chairman
Atomic Safety & Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dr. Linda W. Little
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, N. Carolina 27709

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Mr. Rick Konter
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Atomic Safety & Licensing Appeal Board Panel
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