ATTACHMENT B

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

John F. Wolf, Chairman
Dr. Linda W. Little
Dr. Forrest J. Remick

In the Matter of	)	Docket Nos. 50-295
	)	50-304
COMMONWEALTH EDISON COMPANY	)	FOL Nos. DPR-39 & DPR-48
	)	Proposed Amendment to
(Zion Station, Units 1 and 2)	)	Permit Storage Pool Modification

INITIAL DECISION
(February 14, 1980)

Appearances

Michael I. Miller, Esq., Philip Steptoe, Esq., and Alan P. Bielawski, Esq., Chicago, Ill., for the Commonwealth Edison Company, Applicant

Susan N. Sepuler, Esq., and Anne K. Markey, Esq., Assistant Attorneys General, Chicago, Ill., Intervenor

Richard J. Goddard, Esq., and Steven C. Goldberg, Esq., Washington, D.C., for the Nuclear Regulatory Commission Staff.

INITIAL DECISION

I. PRELIMINARY STATEMENT

1. The Commonwealth Edison Company (Applicant) has applied to the Nuclear Regulatory Commission for permission to install new storage racks in the spent fuel pool at the Zion, Illinois Nuclear Generating Station. The proposed new storage racks in the spent fuel pool would increase the pool's storage capacity from 868 to 2112 fuel assemblies.

2. On April 13, 1978, the Applicant formally requested the issuance of a license amendment. Notice of the proposed amendment was published in the Federal Register on July 18, 1978, 43 Fed. Reg. 30938. The State of Illinois (Intervenor) filed a timely petition for leave to intervene in these proceedings and requested a public hearing on the application be held.

3. A Special Prehearing Conference was held on November 20 and 21, 1978, at Waukegan, Illinois for the purposes of ruling on Intervenor's standing to intervene as a party in the proceedings and determining whether certain of Intervenor's contentions met the legal requirements of the Nuclear Regulatory Commission's Rules of Practice. Limited appearance statements were taken at that time.

4. On January 19, 1979, the Board admitted the State of Illinois as an intervening party and ruled upon the admissibility of certain of Intervenor's contentions.[1/]

5. Subsequently, Motions for Summary Disposition were filed by Applicant and the Nuclear Regulatory Commission Staff (Staff). Certain of Intervenor's contentions were summarily dismissed on the grounds that no genuine issues of material fact existed as to those contentions.[2/]

6. An evidentiary hearing was held in Zion, Illinois from June 11 through June 15, 1979 and from June 20 through June 22, 1979, at which time evidence was presented by the parties with respect to the remaining controverted contentions and Board questions. During these hearings all interested members of the public who wished to make limited appearance statements were heard.

7. Shortly after the submission of Proposed Findings of Fact and Conclusions of Law by the parties, the Board was apprised by a Board Notification entitled "Pipe Cracks in Stagnant Borated Water Systems at PWRs" dated August 14, 1979, and IE Bulletin 79-17 that the use of type 304 stainless steel raised possible problems under the conditions found in the Zion spent fuel pool. This information caused the Board to reopen the record on its own volition to receive evidence

1/ Order Following Prehearing Conference dated January 19, 1979.

2/ Order dated May 1, 1979; Order dated June 4, 1979.

regarding the safety of the proposed fuel storage racks to be used in the Zion spent fuel pool. Affidavits by experts were submitted by the parties. That evidence was considered in arriving at this Initial Decision.[3/]

3/ Board's Memorandum and Order dated September 14, 1979.

II. FINDINGS OF FACT

A. Environmental Impact Appraisal

1. Adequacy

Contention 2(a) states:

> The State of Illinois contends that approval of the proposed license amendment would be a major action of the Commission significantly affecting the quality of the human environment in Illinois. The National Environmental Policy Act of 1969, as amended, requires the Commission to submit an environmental impact statement with respect to the proposed license amendment.

The Staff performed an environmental evaluation of the proposed modification pursuant to the National Environmental Policy Act of 1969, as amended (NEPA). The Environmental Impact Appraisal (EIA) was issued March 29, 1979.[4/] The EIA describes and evaluates the Zion facility, its need for increased spent fuel storage capacity, environmental impacts of the proposed modification, environmental impact of postulated accidents, alternatives for spent fuel storage, and cost-benefit balance of the proposed modification as compared to alternatives. Under the heading, "Basis and Conclusion for Not Preparing an Environmental Impact Statement",[5/] the EIA states:

> We have reviewed this proposed facility modification relative to the requirement set forth in 10 CFR Part 51 and the Council on Environmental Quality's Guidelines, 40 CFR 1500.6, and have applied, balanced, and weighed

4/ Staff Ex 1B.

5/ *Id.* at § 10.0.

> the five factors specified by the Nuclear Regulatory Commission in 40 Fed. Reg. 42801. We have determined that the proposed license amendment will not significantly affect the quality of the human environment and that there will be no significant environmental impact attributable to the proposed action other than that which has already been predicted and described in the Commission's Final Environmental Statement for the facility dated December 1972. Therefore, the Commission [sic] has found that an Environmental Impact Statement need not be prepared and that, pursuant to 10 CFR 51.5(c), the issuance of a negative declaration to this effect is appropriate.

The conclusions set forth in the EIA were supported by Staff's and Applicant's witnesses:

(1) The proposed modification will not require any additional commitments of land, since it will alter only the spent fuel storage racks in the existing spent fuel pool.[6]

(2) There will be no significant change in plant water consumption or use as a result of the proposed modification.[7]

(3) The potential offsite radiological environmental impact associated with expansion of the spent fuel storage capacity will be environmentally insignificant[8] either to the atmosphere[9] or to receiving waters.[10]

6/ Id. at § 5.1; Testimony of Tom R. Tramm (Tramm) at p. 3 following Tr. 564.

7/ Staff Ex. 1B, § 5.2; Tramm at pp. 4-5.

8/ Staff Ex. 1B, § 5.3.1.

9/ Id., § 5.3.2; Tr. 885, 1060, 1065.

10/ Staff Ex. 1B, § 5.3.4.

(4) The additional solid radioactive waste resulting from the proposed modification would result from increased loading on the pool purification system[11/] and from disposal of the present spent fuel pool racks.[12/] The present filtration demineralization system is capable of handling the increased loading.[13/] The total amount of waste shipped from the plant will be increased by about 2 percent (as averaged over the lifetime of the plants) and will have no significant environmental impact.[14/]

(5) The proposed modification will not result in any significant increase in radiation doses received in onsite occupational exposure;[15/] it should add less than 1 percent to the total annual occupational radiation exposure burden at the facility.[16/]

(6) There will be no change in the chemical or biocidal effluents from the plant as a result of the proposed modification.[17/]

(7) The proposed modification will not result in any significant increase in the plant thermal discharge,

11/ Id., § 5.3.3; Tr. 592, 776.

12/ Staff Ex. 1B, § 5.3.3; Tramm at p. 5.

13/ Staff Ex. 1B, § 5.3.3.

14/ Id.

15/ Staff Ex. 1B, § 5.3.5; Testimony of George J. Pliml (Pliml) at p. 5 following Tr. 677.

16/ Staff Ex. 1B, § 5.3.5.

17/ Id., § 5.3.8; Tramm at p. 6.

since the increased thermal discharge would be less than 0.04 percent of the estimated total thermal discharge to Lake Michigan.[18/]

(8) No environmental impact on the community is expected to result from the fuel rack conversion itself or from subsequent operation of the pool with increased amounts of spent fuel.[19/]

The Staff and Applicant testified in regard to Contention 2(a). The Intervenor did not present any direct testimony regarding this contention.

2. Proper Issuance

Intervenor raised questions relating to the timing of the decision to issue an EIA rather than an Environmental Impact Statement (EIS)[20/] and to the similarity of the EIA for Zion to those for other spent fuel pool modifications,[21/] such as Salem.[22/] Consequently, Intervenor questioned the adequacy, independence, and site-specificity of the assessment of the environmental impacts of the proposed modification.[23/] The Board requested that the Staff substantiate that the EIA was performed after specific examination of plant design and in consideration of conditions unique to Zion Station, including its location and possible

18/ Staff Ex. 1B, § 5.3.8 ; Tramm at p. 4.

19/ Staff Ex. 1B, § 5.3.9; Tramm at p. 6.

20/ Tr. 612-614.

21/ Tr. 629-641.

22/ Public Service Co. of New Jersey, Docket No. 50-272.

23/ Tr. 623, 629.

impact on the environment and the human health of the surrounding area.[24/] Staff's response was that the full range of potential site-specific environmental impacts for the construction and continued operation of Zion was considered in the Staff's Final Environmental Statement (FES), issued December 1972, and that in the environmental review pertaining to the proposed modification, the Staff evaluated whether the modification would result in potential for <u>increasing</u> impacts previously evaluated in the FES.[25/] The Staff explained similarities in language of the EIA's for Zion and Salem by noting that the Staff's witness was project manager responsible for both rerackings,[26/] and that relevant portions of both documents discuss generic issues applicable to all fuel pool modifications regardless of location.[27/]

The Board notes that the timing of the decision that an EIS was not necessary and the marked similarity of the EIA at hand to the EIA's for similar facilities raised serious doubts as to the credibility of the EIA for the Zion facility. Resolution of these doubts required extensive questioning of the Staff witness by Intervenor and by the Board.

24/ Tr. 576-577.
25/ Tr. 609-610.
26/ Tr. 611, 629-641.
27/ Tr. 637.

However, based on examination of the EIA itself in conjunction with evidence presented by Staff's and Applicant's witnesses at the evidentiary hearing, the Board finds that the proposed modification will not significantly increase the environmental impact of the Zion facility. Accordingly, the proposed action is not a major action of the Commission significantly affecting the quality of the human environment. Thus, no environmental impact statement is required, and the EIA satisfies the requirements set forth in 10 CFR 51.5 and 10 CFR 51.7.

B. Nuclear Regulatory Commission's "Notice of Intent"

Intervenor's Contention 2(b) states:

> Approval of the amendment request would be contrary to the NRC policy position on spent fuel storage which prohibits non-emergency licensing of any existing storage facility prior to the adoption of an official long term policy regarding the permanent storage of spent fuel. See "Intent to Prepare Generic Environmental Impact Statement of Handling and Storage of Spent Light Water Power Reactor Fuel", 40 F. R. 42801, September 16, 1975.
>
> (1) There is no emergency need to rerack as the existing storage pool contains more space than is necessary to accommodate full core discharge.
>
> (2) The existing pool is able to accommodate normal refueling discharges until 1981; therefore, failure to grant the application at this time poses no threat of imminent shutdown of the facility.

Contention 2(b) cites the Nuclear Regulatory Commission's "Notice of Intent to Prepare Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel" (hereinafter "Notice of Intent"). At the time of the evidentiary hearing, the generic environmental impact statement (GEIS) had only been issued in draft form.[28/]

In its Notice of Intent, the Commission specifically noted that in the interim period, i.e., prior to issuance of

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28/ NUREG-0404, March 1978. The final generic environmental impact statement has now been issued. NUREG-0575, "Final Generic Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel", August 1979. Even though the GEIS has been issued, the Board is proceeding on the basis that Commission policy stated in the Notice of Intent is applicable until modified by the Commission.

the GEIS, a licensing action intended to ameliorate a possible shortage of spent fuel storage capacity could proceed, provided it was accompanied by an EIA (10 CFR § 51.5(c)) or EIS (10 CFR § 51.5(a)) tailored to the facts of the case. In each such licensing action, it is incumbent on the Board to apply, weigh, and balance five factors, i.e.: (1) the likelihood that each individual licensing action of this type would have a utility that is independent of the utility of other licensing actions of this type; (2) the likelihood that taking any particular licensing action of this type during the time frame under consideration would not constitute a commitment of resources that would tend to significantly foreclose the alternatives available with respect to any other individual licensing action of this type; (3) the likelihood that any environmental impacts associated with any individual licensing action of this type would be such that they could adequately be addressed within the context of the individual license application without overlooking any cumulative environmental impacts; (4) the likelihood that any technical issues that may arise in the course of a review of an individual license application can be resolved within that context; and (5) the likelihood that deferral or severe restriction on licensing actions of this type would result in substantial harm to the public interest.

The EIA examined each of the five factors. With respect to the first factor, Staff, Applicant, and Intervenor

agree that the proposed licensing action has independent utility in that it will allow Zion Station to continue operating beyond 1983, when lack of spent fuel storage space would otherwise force the Station to shut down until the proposed federal storage facility for spent fuel is in operation.[29/] Upon cross-examination, Staff's witness estimated the availability of some type of federal storage facility by 1986,[30/] but noted that while the Administration has proposed legislation to authorize the government to contract for or to build such facilities, such legislation has not yet been approved.[31/] In further support of the utility of the proposed action, the proposed modification will provide the Applicant with flexibility, even if an offsite facility becomes available in that it will allow accommodation of a full core should it be desirable for operational reasons to offload,[32/] and it will allow more efficient scheduling of spent fuel shipments to the spent fuel repository, since after opening of the repository it will require some time for complete transfer of spent fuel from the various reactors in the country.[33/]

In regard to the second factor, the proposed action will not constitute a significant commitment of material resources (such as steel, aluminum, boron, and carbide).[34/] It will not

29/ Staff Ex. 1B, § 8.4.1; Intervenor's Proposed Findings in regard to Applicant Proposed Finding 38.

30/ Tr. 690, 692.

31/ Tr. 693.

32/ Tr. 691.

33/ Tr. 694-5.

34/ Staff Ex. 1B, § 8.3.2; Tramm at p. 7.

foreclose similar licensing actions at other nuclear power plants, nor will it commit in any manner the NRC to again authorize additional expansion of storage capacity at Zion in 1992, at which time the proposed storage racks will be full if no spent fuel is shipped offsite in the interim.[35]

Based on evidence from the Staff[36] which was not challenged by the Intervenor, there is no indication of any cumulative environmental impacts which have been overlooked in addressing the potential environmental impacts associated with this specific licensing action.

With regard to the fourth factor, the Staff witnesses indicate that they have responded to all technical issues concerning health, safety, and the environment which arose during their review of the proposed license amendment, and that these issues are addressed in the EIA and the Safety Evaluation.[37] The Intervenor stated that the technical issues have not been resolved and as examples pointed to the various technical contentions at issue in the hearing. Further, the Board on its own motion asked the parties to address certain technical issues which were not explicitly dealt with in the Staff's EIA and Safety Evaluation. In addition, the Board subsequently reopened the record to receive evidence regarding the safety of the

35/ Staff Ex. 1B, § 8.4.2.

36/ Id., § 8.4.3.

37/ Staff Ex. 1A and 1B.

proposed fuel storage racks to be used in the spent fuel pool.[38/]

The Board interprets the question raised by the fourth factor to be whether there are technical issues in this individual licensing proceeding which remain unresolved. The Board finds that there are no technical issues which have arisen during the review of this license amendment application which have not been resolved within the context of this proceeding.

In regard to the fifth factor, deferral or severe restriction of this licensing action would result in substantial harm to the public interest. Without such action, evidence indicates that the Zion Station will lose full core discharge capability in 1981, followed by certain shutdown in 1983. After 1981, there would be a possibility of shutdown at any time due to lack of space in the spent fuel pool to accommodate offload of a full core.[39/] Shutdown would harm the public interest in that Applicant's ability to meet electrical energy needs could be adversely affected, or the energy needs might have to be met by plants which have greater environmental impact or which are less economical to operate.[40/]

In regard to urgency to implement the proposed modification, Applicant testified that while there is no emergency need to install absorber racks at Zion by fall 1979 (the next

38/ Board Memorandum and Order, September 14, 1979.

39/ Staff Ex. 2B, § 2.0; Testimony of Gary G. Zech (Zech) on Contention 2(b) at p. 2 following Tr. 607.

40/ Staff Ex. 1B, § 8.4.5; Zech at pp. 2-3; Pliml at p. 6.

scheduled refueling outage),[41] replacement of the spent fuel racks should proceed as soon as possible to minimize occupational exposure, since the less spent fuel in the pool at the time of reracking, the less time and labor will be required to effect the change. However, any additional occupational exposure incurred by delaying reracking until after fall 1979 would still be well within limits set forth in 10 CFR Part 20.[42] The Board finds, accordingly, that while deferral of the spent fuel pool modification will not cause occupational exposure to exceed limits, it will be in the public interest to keep exposure to a minimum by reracking as soon as feasible consistent with implementation of adequate quality assurance programs and reracking procedures.

41/ Pliml at p. 6.

42/ Pliml at p. 6.

C. Need for Continued Operation of Zion Station

Contention 2(c) states:

> Should it be necessary to shut down the Zion facility, pending the development of an alternate, away from reactor facility, the Applicant has not shown that the community currently being served by Zion would be adversely affected economically or by experiencing loss of electricity.
>
> (1) The Applicant has not explored the possibility of meeting current demand by increased use of underutilized fossil-fueled plants serving the Edison system.
>
> (2) The Applicant has not considered curtailing the output from Zion in conjunction with a conservation program and coordinated rate structure which would reduce the demand for electricity in the area served by Zion.

Applicant and Staff submitted testimony in regard to Contention 2(c).[43/] Shutdown of Zion units in the early 1980's could adversely affect Applicant's ability to meet electrical energy needs and could force operation of other plants which are less economical to operate, with resulting increased costs which would be borne by customers. Applicant estimated an average cost of $441,000[44/] per day with both Zion units out of operation[45/] or $178,000 per day with one unit out of

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43/ Testimony of Roland Kraatz (Kraatz) following Tr. 815; Testimony of Argil L. Toalston (Toalston) following Tr. 846.

44/ Expressed in constant 1978 dollars; does not assume any inflation rate or escalation rate in replacement power costs. Tr. 836-7.

45/ Kraatz at p. 2.

operation.[46] Staff's witness estimated an average cost of $240,000 per day with both units out of operation.[47] Staff also estimated replacement energy costs of $3.6 million per month if Zion were operated at half load, a measure assumed to reduce generation of spent fuel by a factor of two and thus extend available storage capacity of the spent fuel pool to late 1986.[48] Differences in Staff's and Applicant's estimates of costs were attributed to differences in assumptions related to two factors, i.e., source of replacement power and capacity factor Staff assumed a much greater reliance on cheaper high-sulfur coal burning units[49] although Staff's witness admitted that use of high-sulfur coal might not be permitted due to environmental considerations.[50] In regard to capacity factor, Staff's estimate of 58 percent was based on nuclear power plants in general, rather than on actual capacity factors (67 percent) experienced at Zion Station in the past two years. Because of the conservative assumptions used by the Staff, Staff's witness noted that actual replacement costs would exceed his estimate.[51]

46/ At the hearings Kraatz testified that this cost would be $262,000 per day (Tr. 832); however, by affidavit dated July 9, 1979, he stated that his testimony was in error and supplied the lower estimate given above.

47/ Toalston at p. 2.

48/ Staff Ex. 1B. § 7.6; Tr. 843, 847-8.

49/ Tr. 849, 871.

50/ Tr. 864-865.

51/ Tr. 850.

Applicant's calculations are based on comparison of cost of fuel used in generating electricity at Zion Station with equivalent fuel-related costs for other nuclear, coal, and oil-fired generating units (primarily within the Commonwealth Edison System) which would be required to replace Zion's output.[52/]

Applicant also estimated that the portion of Zion's output which would be replaced by oil-fired generating units would require burning approximately 850,000 gallons of oil per day (300 million gallons per year).[53/]

Applicant's witness further noted adverse effects on reliability of electric supply should the Zion units become unavailable in the early 1980's in that the estimated peak load reserve levels during the period 1982 to 1985 would be, during most years, substantially lower than the already somewhat low reserve criterion of 14 percent:

1982	2.3%
1983	10.1%
1984	17.1%
1985	12.1%[54/] [55/]

In regard to effect of energy conservation practices on need for power, Applicant encourages energy conservation through customer

52/ Kraatz, Attachment A.

53/ Kraatz, p. 4; Tr. 815, 837.

54/ Tr. 812; Kraatz, Attachment B.

55/ Based on projection of increased peak load demand at an annual rate of 4-1/2 percent. Tr. 820, 838.

information programs and through time-of-day rates for large industrial customers, and an experimental time-of-day rate program is underway for residential customers.[56/] However, such measures have only a small effect on operation of the Station since it is operated in a baseload manner.[57/]

On cross-examination, Applicant's witness admitted that Applicant has never sent out energy conservation information with customers' electric bills,[58/] and he authenticated a condensed summary of Applicant's rates which indicates that the rates charged to commercial, industrial, governmental, and school customers reflect a "declining block rate structure", i.e., the greater the amount of electricity such customers use, the lower the cost per kilowatt hour they pay.[59/] With regard to energy conservation, Staff witness testified that, since a nuclear unit serves the base load rather than peak load portion of the load cycle, a reduction in energy demand would not affect demand upon a nuclear unit. If conservation measures tend to shift the peak load from the peak to the base, the existing nuclear unit becomes even more important. At the same time, if base load is reduced, additional energy generation will likewise be delayed or reduced so that the result is effectively the same.[60/]

56/ Kraatz at p. 4.

57/ Kraatz at pp. 4-5.

58/ Tr. 822.

59/ Intervenor's Ex. 4; Tr. 826-29, 830-31.

60/ Tr. 862-63.

The Board finds that the proposed action, in itself, will not significantly affect the human or other environment,[61] and therefore, no consideration of alternatives is required.[62] However, were such consideration required, the Board finds the preponderance of the evidence to substantiate need for continued operation of the Zion Station unit at least through the 1980's in view of the uncertainty in construction schedules for other generating units in the Commonwealth Edison System.[63]

61/ See Conclusions of Law, *infra*, paragraph

62/ Portland General Electric Co. (Trojan Nuclear Plant), ALAB-531, 9 NRC 263 (1979).

63/ Kraatz at p. 3.

D. Accidents

1. Drop of Heavy Objects.

Contention 2(f) states:

> There has been insufficient development of credible accident scenarios. For example:
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> (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 radionuclides, has not been precluded.
>
> (2) there is insufficient information regarding the methods by which accidental damage to stored spent fuel assemblies will be prevented during the installation of the new poisoned spent fuel storage racks.

In order to prevent damage to spent fuel assemblies stored in the pool, procedures will be utilized such that neither the old racks being removed nor the new absorber racks which are being placed in the pool will be carried over the spent fuel.[64]

The rack replacement operations will be supervised by fuel handling foremen, who have a limited senior reactor operator's license.[65] At least one of the fuel handling foremen will be present at all times. They will direct the activities

64/ Testimony of John P. Leider, Sr. (Leider) at pp. 3-4 following Tr. 755; NRC Staff Testimony on Contention 2(f)(2) at pp. 1-2 following Tr. 1960.

65/ Tr. 1888.

of the fuel handlers, who will receive refresher training before each semi-annual refueling outage. In addition, prior to the proposed rack replacement, they will review the procedures, the lifting rig, and the techniques to be used, and they will conduct a test lift using the main crane and the lifting frame attached to a new rack.[66/]

Assurance that racks will not be lifted over stored spent fuel during the proposed rack replacement operation will be provided during much of the rack movement by crane interlocks which prevent loads moving over the pool. During those portions of the rack replacement which must involve movement over the pool with the interlocks bypassed, written procedures will be in effect to prevent movement of the racks over the stored spent fuel. The interlock is bypassed through use of a key which is in the possession of the senior licensed fuel handling foreman. Administrative controls will be required during portions of the rack replacement which involve movement of the racks over the pool because of the difficulty of devising mechanical interlocks to restrict crane movement when a number of directional coordinates are involved. The administrative controls on rack movement will be set forth in written procedures and enforced by the crane operator, under the direct supervision of a licensed fuel handling foreman. The written procedures for rack installation are being developed at Zion Station and have not yet been finalized.[67/]

66/ Leider at p. 3.

67/ Tr. 1890-1891, 1896-1897, 1913.

A spent fuel shipping cask will not be carried over the pool during the proposed rack replacement operation. Such casks will not be involved in the proposed modification. Furthermore, there are no casks in the plant, and there are no plans to bring casks into the plant.68/ By letter dated April 8, 1976 the Applicant made a commitment to notify the NRC in advance should it become necessary to handle heavy loads in the vicinity of the spent fuel storage pool.69/ In addition, the Staff intends to issue a technical specification which will not allow the handling of any loads of greater weight than a single fuel assembly plus the spent fuel handling tool over stored spent fuel. The technical specification will not allow the movement of a shipping cask or an empty fuel rack over the stored spent fuel during the proposed rack replacement. This technical specification will be included in any licensing amendment issued to permit the proposed rack replacement.70/

The consequences of hypothetical drop accidents related to the proposed rack replacement were considered. These include the drop of a rack onto the pool floor, the drop of a fuel assembly onto a storage rack during the transfer of the stored fuel from the old racks to the new racks, and the drop of one fuel assembly being transferred onto another stored fuel assembly.

68/ Leider at p. 2; Tr. 1903.

69/ Tr. 1980-1981.

70/ Staff Ex. 1A (SER), § 2.3; Tr. 1963, 1965, 1971.

The drop of a rack onto the pool floor will not result in major damage to the pool structure allowing gross leakage.71/ Although this drop accident was not specifically analyzed, during the original plant design and safety review it was determined that the drop of a much heavier shipping cask into the pool would not result in through-the-slab cracking and gross leakage.72/ It is credible that such a drop could tear the stainless steel pool liner.73/ Beneath the liner a network of channels is embedded in the surface of the concrete pool structure which would collect the water draining through such a tear. The water collected in this manner is piped through six 1-1/2" pipes through the concrete walls of the pool to a collection tank for processing as liquid radwaste and recycle in the plant. It is anticipated that pool water would not escape through the concrete structure of the pool to the outside environment. At the maximum drainage rate through these pipes a minimum of 23 hours would be available either to repair the liner or to add makeup water. Temporary measures can be taken to reduce the leak rate.74/ Damage to

71/ Testimony of Tom R. Tramm (Tramm) at pp. 9-10 following Tr. 564; Tr. 1920-1981; Testimony of Gary G. Zech (Zech) on Contention 2(f)(1) at p. 2 following Tr. 1958.

72/ Tr. 1966-67.

73/ Tr. 1903, 1970.

74/ Tramm at pp. 10-11; Tr. 1911-12.

the liner which might result from the drop of a fuel cask would be within the makeup capability of the various water sources that exist at the plant and would envelope the damage which might result from the drop of a rack.75/

The consequences of a drop of a single fuel assembly onto one of the new storage racks was analyzed.76/ The assembly was hypothesized to drop from a height of 24 inches, which is the maximum height at which such an assembly can be transported over stored fuel.77/ The criterion used was that no structural part of the rack which is required to maintain K-effective less than 0.95 should be stressed beyond the elastic limit. The part of the rack which could be damaged will not contain neutron absorber material. Therefore, no increase in K-effective should occur as a result of this accident.78/ The deformation at the top of the fuel rack resulting from such an accident could temporarily hinder the withdrawal of a fuel assembly stored in the tube at the time. However the tubes are made of light material, which could be straightened so that the assembly could be removed.79/

75/ Tr. 1980-1981; The sources of makeup water at the Zion Station are discussed infra, in response to Board Question 4, pp. 84-86.

76/ Testimony of Quazi Anwar Hossain (Hossain) following Tr. 1700; Applicant's Ex. 4 (Licensing Report), §§ 3.4, 3.5, and 3.4.4.

77/ Hossain, Attachment B.

78/ Tr. 1713-1717.

79/ Tr. 1717-1718.

The consequences of a fuel assembly dropping directly on top of another fuel assembly from a height of 2-1/2 feet were also analyzed. No damage to any of the fuel rods in either assembly should occur as a result of such a drop.[80/]

During the review at the operating license stage, the design basis fuel handling accident considered was the drop of a spent fuel assembly onto the spent fuel pool floor and the breaking of all the fuel rods in the assembly. The analysis of the postulated accident is documented in Section 14.2.1 of the Zion Final Safety Analysis Report (FSAR), where it is indicated that the plant's safety and clean-up systems are adequate to keep the consequences of this occurrence to within 10 CFR Part 100 limits.[81/]

The additional handling required to shift stored fuel assemblies from the old racks to the new racks will increase the probability of a fuel assembly drop.[82/] The reracking will necessitate about 400 extra fuel moves, which would add less than 1 percent to the total number of fuel moves anticipated during the plant's lifetime. The consequences of a fuel assembly drop will not be increased by the proposed reracking.[83/] Further, the consequences would be less than

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80/ Tr. 1964-1965, 1982-1983.

81/ Tramm at pp. 25-27; Hossain at p. 3; NRC Staff Testimony on Contention 2(f)(2) by John J. Zudans (Zudans) at p. 3 following Tr. 1960; SER § 2.3.

82/ Tramm at p. 27; Zudans at p. 3.

83/ Leider at p. 8; Tramm at p. 27.

the consequences of dropping a fuel assembly freshly removed from the reactor during refueling, which was the assumption used for the design basis fuel handling accident.[84/]

There are four loads lighter than a fuel assembly which are handled over stored fuel. These are the spent fuel handling tool, the burnable poison tool, the rod cluster control changing fixture; and the thimble plug. Although lighter than a single fuel assembly, these four loads could develop greater kinetic energy because of greater potential drop heights. Accordingly, the Staff intends to issue a technical specification change which will require that none of these loads be transported at a height greater than 2 feet over the storage racks.[85/]

The Board finds that the Applicant and the Staff have provided sufficient information with respect to the methods, procedures, and technical specifications which will be utilized to prevent accidental damage to stored spent fuel assemblies or the spent fuel pool liner during the installation of new spent fuel storage racks. Therefore, the Board finds that the risks associated with accidental damage to the stored spent fuel or to the pool or its liner during the proposed modification are such that the modifications can be conducted without jeopardizing public health or safety.

84/ Zudans at p. 3.

85/ SER, § 2.3.

2. Pool Boiling.

Contention 2(g) states:

> The Applicant's discussion of spent fuel boiling is inadequate in that (1) there is no consideration given to the possibility that the pool might boil, and (2) there is no discussion of possible damage to fuel cladding or of the consequent release of radionuclides under such conditions; therefore, there is no assurance that public health and safety will not be endangered.
>
> In addition, the heat removal capacity of the spent fuel pool cooling system has not been shown to be adequate to support the expanded pool capacity.

The Zion Station spent fuel pool cooling system has two cooling trains, each of which consists of a pump, a heat exchanger, piping, and associated valves and instrumentation. The spent fuel pool cooling system is itself cooled by the Zion Station component cooling system, which includes five pumps, three heat exchangers and associated piping and valves. The component cooling system transfers the heat load from the spent fuel pool and other station heat sources (primarily the residual heat removal systems, which cool the reactor cores after shutdown) to the service water system, which discharges the heat into Lake Michigan.[86/] The details of these cooling systems are set forth in Sections 9.3, 9.4, and 9.5 of the FSAR and the accompanying FSAR charts.[87/]

86/ Tramm at pp. 12-13.

87/ Applicant's Exs. 3 and 7.

The Applicant analyzed the spent fuel pool cooling system and concluded that either of the two spent fuel pool cooling system trains is sufficient by itself to prevent the SFP water from boiling, even with 2112 spent fuel assemblies stored in the pool, which is the maximum capacity covered by the application.[88/] This conclusion is based on thermohydraulic analyses in which a proprietary computer code named POOLHT was used to calculate bulk fuel pool water temperature as a function of heat input from spent fuel, heat rejection through the pool cooling systems, pool water mass and time.[89/] This showed that for the worst case considered the maximum temperature reached is 180° F.[90/]

The worst case assumptions were that an entire core of spent fuel (193 assemblies from one unit) is discharged ten days following the completion of a normal one-third core refueling discharge from the other unit. This was assumed to occur at a time when only one heat exchanger was operating.[91/] In its Order dated May 1, 1979, the Board inquired whether the fuel pool will reach boiling temperature under such circumstances where the full core discharge from one Zion unit follows the core refueling discharge from the other Zion unit by 10 days or less. The Applicant's witness testified that considering an existing Zion technical specification requiring that fuel transfers not

88/ Tramm at p. 12.

89/ Tramm, Appendices F and G; Licensing Report, § 3.6.

90/ Tramm at p. 18, and Figure 3-22 of Appendix G.

91/ Tramm at p. 18.

begin until 100 hours following reactor shutdown, it is not likely that a full core discharge could be accomplished in less than 10 days following completion of a refueling discharge. However, the Applicant indicated that it would be willing to accept a technical specification restricting fuel movements during core unloading through the imposition of a ten day minimum time for completion of full core discharge.[92/] Both Staff and Applicant indicated that there is no safety reason which would compel the Applicant to move fuel more quickly from the reactor into the spent fuel pool. However, there may be an economic penalty associated with such a delay.[93/]

A calculation of natural circulation flow rates within the pool was performed also to determine thermal loads on the proposed absorber racks and the potential for localized boiling. The maximum increase in water temperature as a result of natural circulation flow up through a fuel assembly in a storage tube was found to be 32.4° F.[94/] These calculations employ a proprietary code named CIRCUS in which the peak power spent fuel assembly is assumed to be stored in the middle of the pool in an east-west row of average power spent fuel assemblies. Water flow in this row of fuel assemblies is assumed to follow a path from the top of the pool, down the side of the pool (in the 9-inch gaps between the proposed new absorber racks

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92/ Tramm at p. 19.

93/ Tramm at pp. 17-19; Tr. 1508-1510; Tr. 1674-1676.

94/ License Report at p. 3-51; Tr. 1753-1754.

and the east and west sides of the pool), through the 7-inch high flow area underneath the racks, through the 5-inch hole in the bottom of the fuel storage tubes, and up through the stored spent fuel assemblies to the top of the pool. This model gives an upper bound for increase in water temperature within the storage tubes, because it ignores flow from the north and south sides of the pool and flow between the racks. Further, the major resistance to flow of cooling water occurs within the stored fuel assemblies themselves. For purposes of the calculations this resistance was maximized by assuming that the fuel assemblies are stored with control rods present. This is not usually done at Zion except in the case of a full core discharge.[95/]

The performance of the spent fuel pool cooling system is related to the other heat loads which are transferred by the component cooling system in that such performance is a function of the temperature of the component cooling system water. Postulated plant upset conditions such as a loss of coolant accident ("LOCA") could increase the temperatures in the component cooling system and therefore possibly cause a temporary reduction in spent fuel pool cooling.[96/] Neither POOLHT nor CIRCUS is modeled to calculate the temperature of the component cooling system during a LOCA. Instead the Applicant

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95/ Licensing Report at p. 3-51; Tr. 1475, 1748-1750, 1754-1757, 1771, 1931.

96/ Tramm at p. 29; Tr. 1460-1461.

made allowance for such conditions in its calculations in its choice of the component cooling water temperature.[97]

The assumption was made that the temperature of the component cooling system water at the inlet to the spent fuel pool heat exchangers was 80° F. On cross-examination, Applicant's witness admitted that the corresponding temperature in the FSAR is 95° F. The witness defended this choice by observing that the 95° F temperature assumed in the FSAR is derived from a water temperature in Lake Michigan of 80° F which is conservatively high. The use of 80° F component cooling water assumed a lakewater temperature of 70° F. The records of lakewater temperature in the Zion Final Environmental Statement, Appendix D, indicate that this lower temperature is conservative, in that the maximum recorded average monthly lakewater temperature at Waukegan is 63° F in August. In contrast, refuelings normally take place in the spring and fall of the year when lakewater temperatures are less. If a value of 90° F for the component cooling water temperature had been used, the pool temperatures would have been about 15° F higher.[98]

Using its own analytical methods, the Staff performed calculations of spent fuel pool cooling capacity. Their calculations involved a hypothetical situation similar to the worst

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97/ Tr. 1464, 1466.

98/ Tr. 1454-1455, 1459-1460, 1496-1500.

case assumed by the Applicant in which a full core with a full inventory of fission products is offloaded, filling the last of the 2112 spaces in the pool ten days after the thirtieth refueling. The maximum possible heat load in the spent fuel pool under such circumstances is calculated to be 51×10^6 Btu/hr. If one of the spent fuel pool cooling trains is not operative, the outlet water temperature would rise to about 170° F. Based on these calculations the Staff concluded that the present cooling capacity for the Zion spent fuel pool is adequate for the proposed modification.[99/]

Intervenor's testimony indicated that boiling could occur in the spent fuel pool under two circumstances. The first circumstance would be if there were no cooling of the water in the spent fuel pool. According to the witness this could occur if the component cooling system became overloaded under reactor accident conditions. The second way boiling could occur would be under heat load conditions similar to those analyzed by the Applicant and the Staff, in which a full core discharge follows completion of a normal refueling discharge by ten days or less and only one spent fuel heat exchanger is operative. In this case it was predicted localized boiling could take place.[100/]

99/ NRC Staff Testimony on Contention 2(g) by Richard M. Lobel, Jack N. Donohew and Edward Lantz (Lobel, Donohew and Lantz) at pp. 7-9 following Tr. 1632.

100/ Direct Testimony of Marvin Resnikoff (Resnikoff) at pp. 1, 4-10 following Tr. 1528.

The accident conditions referred to in Intervenor's testimony involved a scenario in which it becomes necessary to cool down both Zion reactors simultaneously using the residual heat removal system. Under such circumstances, he calculated that the total heat load on the component cooling system, taking into account the maximum heat load produced by the spent fuel pool during the 33rd refueling discharge, would exceed the design heat transfer capability of the component cooling system heat exchangers given in the FSAR.[101] However on cross-examination the witness admitted that he had overestimated the total heat load on the component cooling system. Further, that in using the design heat transfer capability given in the FSAR he had underestimated the maximum heat removal capability of the component cooling system, which could be much greater.[102] The witness could not hypothesize any circumstances under which the Applicant would not be able to maintain cooling on one reactor unit through the steam and power conversion system. Therefore he indicated that the heat load from at least one

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101/ Resnikoff at pp. 6-8.

102/ Tr. 1543-44, 1546-47, 1575-76.

reactor unit would not have to be put on the component cooling system under such circumstances.[103/][104/] The witness also conceded

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103/ Tr. 1539-41.

104/ The witness observed that this answer requires an assumption that given a design basis LOCA at one unit at Zion, personnel could operate the second unit. The Board takes notice of General Design Criteria numbers 5 and 19 of 10 CFR Part 50 Appendix A which state:

> Criterion 5 -- Sharing of structures, systems, and components. Structures, systems, and components important to safety shall not be shared among nuclear power units unless it can be shown that such sharing will not significantly impair their ability to perform their safety functions, including, in the event of an accident in one unit, an orderly shutdown and cooldown of the remaining units.
>
> Criterion 19 -- Control room. A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel receiving radiation exposures in excess of 5 rem whole body, or its equivalent to any part of the body, for the duration of the accident.
>
> Equipment at appropriate locations outside the control room shall be provided (1) with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and (2) with a potential capability for subsequent cold shutdown of the reactor through the use of suitable procedures.

that even if the component cooling system were subjected to the extreme heat loads described in his testimony, this would not cause a malfunction of the component cooling system. He agreed that it would require more than a single failure to cause the component cooling system to cease to function.105/

Intervenor's witness estimated that the bulk SFP water temperature would rise to 142.5° F in the event of a full core discharge following a normal refueling discharge by ten days with one heat exchanger operative. However, he further postulated that the 5-inch hole at the bottom of a storage tube which normally allows entrance of cooling water, could become blocked. Under such circumstances, he predicted that localized boiling could occur.106/ On cross-examination, he explained that the hole at the bottom of a tube could become blocked if for example a shoe fell in the pool. However, even if this occurred he indicated that the resulting localized boiling would not boil off enough water to expose the top of the stored fuel assemblies. He indicated that he would not be concerned about damage to the particular fuel assembly from such localized boiling.107/

In its May 1, 1979 Order denying motions for summary disposition, the Board directed the parties to address whether

105/ Tr. 1548-1549.

106/ Resnikoff at pp. 9-10; Tr. 1550-1551

107/ Tr. 1552-1554.

the Zion spent fuel pool cooling system and the component cooling system meet the single failure criterion as defined in 10 CFR Part 50, Appendix A. The component cooling system does meet the single failure criterion.[108] However, the spent fuel pool cooling system does not meet the criterion. A single failure of the pipe which returns water to the pool from the spent fuel pool cooling system could result in a loss of spent fuel pool cooling ability.[109] The Staff testified that the single failure criterion is not applicable to the spent fuel pool cooling system.[110] The Applicant indicated that the Zion spent fuel pool meets the applicable general design criterion in 10 CFR Part 50 Appendix A, which does not incorporate the single failure criterion.[111] [112]

108/ Tramm at p. 20, Tr. 1495-1496, 1510-1513, 1676, 1955-1956.

109/ Tr. 1514, 1676.

110/ Tr. 1654.

111/ Tr. 1494-1495.

112/ Applicant's witness indicated that the applicable criterion is General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control", which states:

> "The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions." Tr. 1495.

Nevertheless, a single failure of the inlet pipe which returns water from the spent fuel pool cooling system to the pool is a credible event.[113/] There is testimony in the record of the consequences of such an event.

Once cooling capability is lost, the Applicant estimates that it would take at least 8.2 hours to boil, assuming the pool were initially at 150° F, which is in excess of the normal pool temperature.[114/] The Staff's estimate is about 8 hours, starting from 125° F (11° F per hour). Intervenor's witness estimated 6.3 to 12.9 hours starting from 150° F, which is in the same range as the Applicant's and Staff's estimate.[115/]

Applicant's witness testified that before boiling would occur the Applicant would have sufficient time to fix a broken cooling system or to add makeup cooling water which would drive down the temperature of the spent fuel pool.[116/] [117/] The Staff testified that there would be sufficient time before boiling commenced to establish a flow of makeup water to the pool equal to the maximum possible boiloff rate.[118/] Intervenor's witness agreed that the question of boiling is negated if a continuing source of readily available makeup water for the Zion

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113/ Tr. 1514, 1677.

114/ Tramm at pp. 20-21.

115/ Resnikoff at p. 2.

116/ Tramm at pp. 21-23.

117/ The sources of makeup water at Zion Station are described in more detail in response to Board Question 4, pp. 84-86.

118/ Lobel, Donohew and Lantz at pp. 8-9.

spent fuel pool is guaranteed. He also agreed that the sources of makeup water at Zion Station would be adequate, but only if it would be possible to deliver the water to the pool under all circumstances. For this reason, he suggested that the makeup water systems be fully automated so that human intervention is unnecessary.[119/]

The pumps and heat exchangers of the spent fuel pool cooling system and the controls to the makeup water supply are located in a room in the fuel building which has walls and ceiling of concrete. Such equipment and controls are accessible under any circumstances (even if one of the reactors should experience a LOCA) through a railroad trackway entrance to the fuel building, and this could be done without going past the spent fuel pool.[120/]

In its May 1, 1979 Order, the Board asked the parties to address, if boiling occurs, the possible effect on the integrity of the cladding on fuel which has been stored for a long period of time. There currently is no basis to expect that aged fuel will be jeopardized by boiling conditions in the spent fuel pool.[121/] Further, leakage of radioactivity from a stored spent fuel assembly during spent fuel pool boiling would not be

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119/ Tr. 1556-60, 1570.

120/ Tr. 1559-60, 1485-86, 1500-01, 1688-89, 1859-63.

121/ Testimony of A. Burtron Johnson, Jr. (Johnson) at p. 10 following Tr. 1057.

significantly different from that observed during normal pool operation.[122] Intervenor submitted no testimony dealing with the effect of boiling on stored spent fuel in conditions where the stored fuel is not exposed to the air.[123]

If boiling were to occur some non-volatile radioactivity normally present in the pool water could be entrained in water droplets in the air above the pool. These droplets would condense out on surfaces in the fuel building or ventilation ducts or be removed by the building filtration system. After boiling commenced access to the pool area would have to be controlled to maintain exposures as low as reasonably achievable, but people could still enter the pool area.[124]

Conditions of high humidity caused by pool boiling, if continued for very long, could disable the prefilters and HEPA filters in the building filtration system. However, boiling would not need to be allowed to continue for such a length of time. Further, the Applicant could replace the filters even during conditions of high radioactivity within the fuel

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122/ Lobel, Donohew and Lantz at pp. 4-7.

123/ Tr. 1526.

124/ Lobel, Donohew and Lantz at p. 6; Tr. 1485-86, 1651-52.

building. Accordingly, changes to the fuel building filtration system are not required to account for the possibility that the pool might boil.[125/]

Boiling in the spent fuel pool would have a negligible effect on the pool liner. Further, a rise in pool temperature to boiling and continued boiling for a period of up to 5 to 7 days would not affect the design behavior or structural integrity of the concrete in the spent fuel pool.[126/]

Boiling should have no effect on the neutron absorbing material (Boral) present in the proposed storage racks. Boiling would tend to increase the concentration of boric acid in the pool water, since the water would boil away but the boric acid would remain.[127/] These higher concentrations of boric acid could be continued for a period of at least two weeks before they would have an effect on corrosion of the metals within the storage tubes.[128/]

Intervenor's witness discussed an accident which might follow if the water in the spent fuel pool were allowed to boil away, uncovering the stored spent fuel assemblies.

125/ Tr. 1678-82.

126/ Tr. 1880-83, 1885.

127/ Tr. 1664, 1683-84.

128/ Tr. 1324-27.

According to his calculations, if no makeup water were added, the tops of the spent fuel racks would be uncovered in a period of 2.9 to 5.9 days following initiation of boiling. The witness testified that after being uncovered the spent fuel assemblies would heat up rapidly, and above 920° C an exothermic metal-water reaction would take place producing large amounts of heat and hydrogen gas. He indicated that the hydrogen liberated by this reaction could subsequently explode, which might lead to a major release of radioactivity from the spent fuel building. Because of the large inventory of radioactive materials in the spent fuel pool, he stated that such an accident would be much more severe than a reactor melt-down accident.[129/] In support of his thesis that exposure to air of stored spent fuel could lead to a serious accident, the witness cited a report by Sandia Laboratories,[130/] a copy of which had been served on all parties by the Staff.

Neither the Applicant nor the Staff has performed calculations relating to the possible heat up of spent fuel following exposure to air or the radiological consequences of such an event. Both take the position that such a loss of water accident at Zion Station is not credible.[131/]

The Board finds that the Intervenor has not presented a sufficiently probable sequence of events by which boiling in

129/ Resnikoff at pp. 2-4, 11-19.

130/ NUREG/CR-0649, "Spent Fuel Heatup Following Loss of Water During Storage", A. S. Benjamin, *et al*., March 1979.

131/ Tr. 1486-1487, 1654-1656.

the spent fuel pool could lead to a loss of water accident of the kind described in the Sandia Report or in testimony of its witness. Even according to the witness there would be a minimum of three to six days to add water to the pool to prevent this occurrence, and the witness concedes the supplies of makeup water at the Station are adequate for this purpose. Although he has raised a question whether human intervention to add makeup water would be possible under all circumstances, the Applicant and the Staff have testified, without contradiction on this record, that such intervention would always be possible. There is no reasonable basis for the witness's speculation that such an accident might be allowed to occur through neglect. Further, his concern that during a war or other period of social disruption the Applicant might "simply turn off the cooling system and walk away" from the generating station is without basis.132/ 133/

132/ Tr. 1561-62.

133/ The Board takes notice of 10 CFR Part 50, § 103, which states, in part:

> § 50.103 Suspension and operation in war or national emergency. (a) Whenever Congress declares that a state of war or national emergency exists, the Commission ... may,
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> . . . .
>
> (3) Order the operation of any licensed facility.
>
> (4) Order entry into any plant or facility in order to recapture special nuclear material or to operate the facility. . . .

The Board finds that the heat removal capacity of the Zion spent fuel pool cooling system and related cooling systems is adequate to support the expanded pool capacity. The Board finds that the analysis of possible spent fuel pool water boiling is adequate. The Board also finds that if boiling should occur in the spent fuel pool, there should be no damage to fuel cladding and no significant increase in the release of radionuclides. The Board finds that there are sufficient sources of makeup water and adequate access to such sources to ensure that the public health and safety is not endangered by boiling in the spent fuel pool.[134] The Board finds no basis in the record to require a technical specification which would restrict fuel movement during core unloading by imposing a ten-day minimum time on the completion of full core discharge.

134/ Although Contention 2(g) and Intervenor's testimony dealt only with loss of water accidents in the spent fuel pool caused by boiling, such accidents could be hypothesized to occur through other means. Accordingly, the Board on its own motion directed the Applicant and the Staff to summarize the design and/or engineered safeguards at the Zion spent fuel pool which decrease the likelihood of severe pool drainage accidents. The Board's findings with respect to these safeguards are found on page 86 below.

E. Corrosion

Contentions 2(e)(3) and (4) state:

> 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 the construction of the racks.

Contention 2(h) states:

> 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 Perkins storage racks, and the stainless steel pool liner.

Contention 2(i) states:

> The Applicant has not discussed whether the proposed modification and long term storage may cause the following effects on the stored fuel: accelerated corrosion, micro-structural changes, alterations in mechanical properties, stress corrosion, cracking, intergranular corrosion, and hydrogen absorption and precipitation by the zirconium alloys.

Contention 2(j) states:

> The amendment request and supporting documentation do not give sufficient data to fully assess the durability and performance of the Boral-stainless steel 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.

Contention 2(k) states:

> The amendment request and supporting documentation do not consider possible degeneration of the Boral density due either to generic defects or to mechanical failure which would diminish the effectiveness of Boral as neutron absorber, thus leading to criticality in the spent fuel pool.

The proposed storage racks consist of a welded array of rectangular stainless steel tubes into which the spent fuel assemblies will be inserted. Within each stainless steel tube are four neutron-absorbing Boral sheets, one on each side. On each side of each tube, near the top, is a 1/4-inch vent hole which penetrates the inside stainless steel wall and which will allow spent fuel pool water to enter the tube and come in contact with the Boral material.[135/] Boral is a product manufactured by Brooks and Perkins, Inc. which consists of boron carbide (B_4C) particles embedded in a matrix of commercially pure (1100) aluminum formed into a plate and clad with 1100 aluminum on both sides.[136/]

The materials exposed to water in the spent fuel pool are stainless steel in the pool liner, in the spent fuel assemblies and in the storage racks; Zircaloy and Inconel in the

135/ Applicant's Proprietary Ex. 6.

136/ Testimony of J. E. Draley (Draley) at p. 3 following Tr. 1290; Tr. 1261-1263.

spent fuel assemblies; and Boral in the storage racks. Of these dissimilar materials, the stainless steel, Inconel, and Zircaloy have nearly identical electrolytic potential and therefore can be coupled without significant electrolytic or galvanic effects. There is a major difference in electric potential between aluminum and stainless steel and therefore galvanic corrosion will occur between the aluminum cladding in the Boral and the stainless steel tubes which encapsulate the Boral. However, the stainless steel pool liner will not be affected by interaction with the Boral.[137/] There appears to be no basis to expect that the Boral contained in the stainless steel tubes will contribute to degradation of the fuel assembly materials or the pool liner. This is true whether or not the racks are vented, because under the conditions and conductivities in the Zion spent fuel pool, galvanic corrosion requires direct contact.[138/]

Some galvanic corrosion between the Boral sheets and the stainless steel tubes within which they are enclosed will take place. Because stainless steel is electrochemically more noble than the aluminum and Boral sheets, such galvanic corrosion will not affect the stainless steel tubes, nor does it threaten the structural integrity of the racks.[139/] Some pitting of the

137/ NRC Staff Testimony on Contentions 2(e)(3), 2(e)(4), 2(h), 2(i), 2(g), and 2(k) by Frank M. Almeter and Edward Lantz (Almeter and Lantz) at pp. 3-9 following Tr. 1141.

138/ Johnson at p. 6; Draley at p. 9; Tr. 1099, 1118, 1129-30.

139/ Draley at pp. 5-7; Almeter and Lantz at pp. 6-9; Johnson at p. 6.

edges of the Boral plate and perhaps the 1100 aluminum cladding which forms the outside layer of the Boral where the electrical contact with the stainless steel tube is good can be expected. In neither of these two locations is the attack expected to be great enough to lead to serious loss of the neutron absorbing boron in the Boral or to cause corrosion product swelling of the Boral which would interfere with free movement of the spent fuel stored in the racks. The reason for this is that the corrosion will be self-limiting due to the formation of an insulating oxide film over the growing pit.[140/]

During an in camera session, Intervenor raised questions about several proprietary reports describing galvanic corrosion experiments conducted by Brooks and Perkins, Inc., the manufacturer of Boral, and by Battelle-Columbus Laboratories for Brooks and Perkins.[141/] These reports were provided by the Applicant to Intervenor during discovery. The Brooks and Perkins report contains a conclusion that maintaining a significant oxygen concentration in the water surrounding the Boral could lead to unacceptable corrosion behavior. Presumably on the basis of this research the Applicant changed its rack design so that the vent holes through the stainless steel tubes are located only at the top of the tubes, rather than at the top and the bottom. This limits the access of fresh oxygen-bearing pool water to the inside of the tubes. Applicant's

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140/ Draley at pp. 5-6; Tr. 1142-1144.

141/ Intervenor's In Camera Exs. 1 and 2.

witness testified that he did not agree with the Brooks and Perkins report that maintaining oxygen saturation would lead to results that would be unacceptable. However, he had no objection to the closing of the vents at the bottom of the tubes. The Battelle-Columbus report reflects experiments in which a high rate of galvanic attack of Boral in a concentrated boric acid solution was observed. The Applicant's witness testified that this experiment did not influence his testimony very strongly because the boric acid solution involved in the experiment was quite a bit more aggressive than the conditions in the Zion spent fuel pool. Therefore, the results in the Battelle-Columbus report do not apply to the Zion spent fuel pool.[142]

Anodizing the aluminum cladding of the Boral probably would not reduce the amount of corrosion over the 40-year lifetime of the racks. The use of unanodized, rather than anodized, aluminum would lead to accelerated corrosion of the Boral during the first five days after the racks are first immersed in the pool water until a protective aluminum oxide layer is built up. At that point the accelerated corrosion will be over, and thereafter, there will be no significant corrosion.[143]

142/ Tr. In Camera 1342-1343, 1345-1349.

143/ Tr. 1202-1203, 1239-1240, 1250, 1319.

Significant amounts of neutron-absorbing boron will not be lost from the Boral by corrosion. This is because the boron carbide (B_4C) particles are inert to the pool water environment and galvanic corrosion and remain embedded in any aluminum corrosion product. The amount of this corrosion product which flakes away will be very small.[144]

There has been no evidence of pool-stored commercial water reactor fuel degradation to date from visual inspections, radiation monitoring of spent fuel pools, and detailed examinations of selected fuel rods. Unfortunately, visual inspections and radiation monitoring detect only advanced stages of cladding degradation. However, theoretical assessments conducted by an Applicant witness and by others have failed to identify a mechanism which is regarded as a substantial threat to fuel cladding integrity in pool storage. The witness testified that there is sufficient basis at this time to proceed with long term storage of spent fuel. However, he noted that surveillance should continue to be provided for the spent fuel over whatever time period the spent fuel will be stored.[145]

Accelerated corrosion, micro-structural changes, alterations in mechanical properties, stress corrosion cracking,

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144/ Draley at pp. 7-9; Almeter and Lantz at pp. 7-8; Tr. 1250-52, 1358.

145/ Johnson at p. 10 and at pp. 167 and 171 of Attachment B; Tr. 1072-77, 1113-15, 1117.

intergranular corrosion, and zirconium hydriding are not expected to occur to the extent that they would affect the fuel during storage up to 40 years. The corrosion rate of type 304 stainless steel, the type used in the fuel storage tubes, is expected to be negligible.146/

Swelling of unvented storage rack tubes, not involving the swelling of Boral, occurred at Monticello last year. This swelling is believed to have been caused by the accumulation of entrapped gas between the Boral and the stainless steel tube. The gas was a mixture of the air originally in the tube and hydrogen which may have been produced as a corrosion product when water leaked into the unvented Monticello tubes. This kind of swelling should not occur at Zion due to the use of vented racks which will allow gas to escape.147/

There are two processes which could lead to swelling of the Boral within the stainless steel tubes. First, if the Boral is porous, water could permeate into the core material. It would then be possible for the water to react with the aluminum at some internal place to produce hydrogen gas in quantities sufficient to expand the Boral forming an internal blister. This type of swelling should be self-limiting, since expansion of the blister should deform the piece enough to allow release of hydrogen pressure. Some swelling of this type has occurred in tests

146/ Draley at pp. 2-3, 10; Almeter and Lantz at pp. 8-12.

147/ Draley at p. 13; Almeter and Lantz at pp. 12-13.

conducted by Exxon Nuclear Company, but the Boral samples used were not of the type of material used in the Zion racks. The Exxon samples differed in that they contained quantities of finer mesh boron carbide particles and areas of imperfect bonding within the Boral between the aluminum cladding and the B_4C/aluminum matrix. This type of swelling should not occur in the Zion racks where there will be good quality control.[148/]

The second type of Boral swelling which might occur would be related to local corrosion or pitting which might be induced by galvanic interaction between the aluminum in the Boral and the stainless steel tubes where the two plates are pressed together. The solid corrosion product has a greater volume than that of the metal, and local swelling could result. Using the density of the predominant aluminum corrosion product, Bayerite, the corrosion product could occupy a volume some 3.2 times that of the aluminum from which it is formed. Even if a Boral plate in a Zion storage tube corroded all the way through (cladding and core material), the maximum swelling produced by the corrosion product was calculated to be 0.234 inch, an amount which would not interfere with the movement of fuel within storage tubes.[149/]

Mechanical failure which might cause the Boral to fragment or break is not likely in view of the record of Boral products and in view of the record of the Boral cladding alloy,

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148/ Draley at pp. 11-12; Almeter and Lantz at p. 13; Tr. 1222-26.
149/ Draley at pp. 12-13; Tr. 1316-18.

1100 aluminum. Further, if mechanical defects should occur, the stainless steel tubing would keep the Boral largely in position. In addition, the Boral plates are not load-bearing elements of the racks. Only the mechanical strength of the stainless steel is relied on in the design of the racks, and the strength of this material will not significantly deteriorate over the life of the racks. The only other effect which could possibly diminish Boral density in the spent fuel pool is radiation. However, the low levels of neutron flux in the pool will have no significant effect on the Boral in 40 years of full time use.[150/]

The surveillance program that the Applicant will use to ensure that unexpected damage to the Boral is not occurring will utilize eighteen small vented stainless steel coupons containing Boral specimens which will be stored in the pool. These coupons will be removed periodically, opened, and examined for corrosion damage. In addition, two full-size storage tubes will be exposed in the pool near stored fuel so as to reproduce the radiation condition as well as exposure to the pool water. These tubes will be examined periodically for visual signs of swelling and will be opened and examined for loss of boron if examination of the small coupons indicates a boron-10 content in the enclosed Boral specimen below 0.02gm/cm^2.

150/ Almeter and Lantz at pp. 15-16; Draley at pp. 13-14.

This surveillance program should adequately detect indications of corrosion damage involving possible loss of neutron absorber or swelling or other damage to the tubes in time to take necessary remedial action for the storage tubes in the pool. Corrosion reactions should be sufficiently slow that any damage that occurs will not endanger the safe and effective operation of the pool.[151/]

On cross-examination by Intervenor, Applicant's witness testified that if the boron-10 content in the coupons fell below 0.02gm/cm^2 and the full length tube specimens also showed some damage, it would be possible, as a general matter, to remove spent fuel from the storage racks and inspect the tubes in the racks. There presently are no plans to monitor the generation of gas or corrosion products within the tubes being used to store fuel. He testified that in view of the Applicant's proposed surveillance program, this is not necessary. Similarly, there are no plans to measure the size of any corrosion products that might flake off within the tubes, or to monitor any accumulation of crud or corrosion products around the vent holes in the tubes. The witness stated that because the density of the corrosion product is greater than that of pool water, there is no force of which he is aware which would make them rise to go to the hole.[152/]

151/ Draley at pp. 8-9 and at Attachment 5; Almeter and Lantz at pp. 2-3.

152/ Draley at pp. 1307-10; Tr. 1357-59.

In response to further questioning by Intervenor, Applicant's witness reaffirmed that the small coupons and full length tubes used as samples in the surveillance program will simulate the behavior of the tubes in the racks adequately to be safe in the identification of any unexpected swelling or problem that occurs. Further, he testified that it is unnecessary to conduct more frequent examination of these samples than the present plan calls for; however, the present schedule could be changed if the Applicant elected to do so. The Applicant has made a commitment to institute the surveillance program at the time it places the racks in the pool, although a delay of a few weeks would not be an undue risk of any kind.[153]

Intervenor's witness questioned the Applicant's surveillance program because there are a small number of coupons to be used and because they may not be truly representative of the tubes to be used in the storage racks, due to the difference in size and because they may not necessarily be mounted in the worst-case environment. However, the witness indicated that at the time he prepared his written testimony that he was not aware of the fact that the Applicant's corrosion surveillance plan included the use of full length fuel storage tubes. The witness stated that specific acceptance criteria should be established in advance for judging the results of any tests performed on

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153/ Tr. 1312, 1320-22.

the samples. Nevertheless, he agreed that by observing corrosion, the Applicant would be a long way toward determining whether or not the ultimate criterion, that is, the neutron absorbing capability of the Boral, is being maintained.154/

Subsequent to the completion of the evidentiary hearing in this matter, the parties were served by the Staff with copies of a Board Notification -- Pipe Cracks in Stagnant Borated Water Systems at PWRs. The Board Notification was dated August 14, 1979 and was signed by Darrell G. Eisenhut, Acting Director of the Division of Operating Reactors.

The Board Notification indicated that cracks have occurred in safety related type 304 stainless steel piping systems which contain stagnant borated water. Affected systems included the spent fuel pool cooling piping at another PWR. The cracking is apparently due to stress corrosion cracking caused by residual welding stresses at heat affected zones.

The Staff indicated that the cracking is not directly related to and does not stem from spent fuel pool modifications; substantial leaking from such cracked piping is not likely;

154/ Testimony of Gregory C. Minor concerning Contentions 2(e), 2(f), 2(h), 2(j) and 4(a) (Minor) at pp. 2-3 following Tr. 1405; Tr. 1417-28. On *voir dire* examination, Mr. Minor admitted that he is not an expert in the fields of corrosion or metallurgy. Tr. 1378-79. Accordingly, the Board approved a motion to strike those portions of the written testimony which purported to express an expert opinion on those subjects. Tr. 1402-03.

necessary repairs can be readily made; and the safety significance of cracks in low pressure spent fuel cooling systems is nil.

However, following the evidentiary hearing, the record of this proceeding indicated that there is stainless steel in the spent fuel pool liner, the spent fuel assemblies, the spent fuel pool cooling system and the proposed fuel storage racks. The stainless steel would be exposed to oxygen-saturated, borated water in the spent fuel pool, if the proposed amendment is issued. Further, the evidentiary record indicated that the mechanical strength of the type 304 stainless steel in the proposed racks would be relied upon by the design of the racks, and that stagnant water would exist within the vented tubes of the proposed fuel storage racks. The record was not clear as to the type of stainless steel in the liner, in the fuel assemblies or in the spent fuel pool cooling system. Further, the record was not clear as to the extent to which the water in the pool would be stagnant, or essentially stagnant, nor to the extent that the water is oxygenated.

Therefore, the Board directed the parties to provide affidavits as to the extent to which type 304 stainless steel will be present in the pool according to the proposed modification plan. Further, in light of the new information contained in the Board Notification, the affidavits were to address what

effects, if any, would occur to the type 304 stainless steel as a result of being immersed in or in contact with the water in the spent fuel storage pool.155/

Following the granting of numerous motions for extensions of time, the affidavits were submitted by late December 1979. In a conference call on January 3, 1980, confirmed by written Order,156/ the Board indicated that there were two issues which the Board found were not addressed by all parties in their affidavits or, if addressed, were not done so in adequate depth. The parties were given until January 24, 1980 to submit additional affidavits.

The Board has considered the additional evidence provided by all the parties. Type 304 stainless steel does exist in the spent fuel pool as follows: in the 3/16" pool liner; in the spent fuel pool cooling system piping, heat exchangers, pumps and valves; in the top and bottom nozzle assemblies of the fuel assemblies; in the rod control cluster assemblies, burnable poison rod assemblies and the control rods; and in the present fuel storage racks. Further, the proposed fuel storage racks would be made of welded type 304 stainless steel sheet, bar and plate.157/

Stagnant water conditions can occur in the two loops of the spent fuel pool cooling system under conditions when a

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155/ Memorandum and Order, September 14, 1979.

156/ Memorandum and Order, January 8, 1980.

157/ Affidavit of Tom R. Tramm at pp. 1-2, November 1979.

loop is isolated. Because there is no convective flow path within the spent fuel storage tube walls, water inside the stainless steel sheaths is expected to be stagnant. Forced flow from the spent fuel pool cooling system and convective flow from the heat from the spent fuel generally prevent the water in the spent fuel pool from becoming stagnant. However, there could be localized stagnant, or near stagnant, conditions in crevices or in narrow spaces between adjoining fuel tubes.[158] The spent fuel pool does contain oxygenated and borated water.[159]

Intergranular stress corrosion cracking of stainless steel can occur if three conditions are present. These include an aggressive environment (e.g., stagnant, oxygenated borated water system; presence of contaminants such as chloride or fluoride); a condition of metallurgical sensitization susceptible to stress corrosion cracking; and high residual or imposed stresses. All three conditions must be present before cracking will occur.[160]

158/ Affidavit of Tom R. Tramm, November 1979 at pp. 3-5; Affidavit of Tom R. Tramm, January 24, 1980 at pp. 1-5; Affidavit of Roger Staehle, January 14, 1980 at p. 1; Affidavit of Robert Neil Anderson, December 17, 1979 at p. 2; Affidavit of Robert Anderson, January 23, 1980 at pp. 3-6; Affidavit of John R. Weeks, December 7, 1979 at p. 2; Supplemental Affidavit of Edward Lantz, January 15, 1980 at pp. 1-3.

159/ Affidavit of Tramm, November 1979 at p. 1; Affidavit of Tramm, January 24, 1980 at p. 1; Affidavit of Anderson, January 23, 1980 at pp. 2-3; Supplemental Affidavit of Weeks, January 10, 1980 at p. 2.

160/ Affidavit of Staehle, November 16, 1979 at pp. 3-4; Affidavit of Staehle, January 14, 1980 at p. 2.

The evidence indicates that an aggressive environment of stagnant, oxygenated, borated water may be present within the vented stainless steel sheaths of the spent fuel storage tubes, and possibly at other locations between tubes. The Applicant makes a commitment to monitor spent fuel pool water chemistry on a weekly basis for chloride and fluoride and indicates that chloride will be maintained below 1.0 ppm and fluoride will be maintained below 0.2 ppm.[161/]

Visual and liquid penetrant examinations were made on one of the existing fuel storage racks in use in the spent fuel pool for approximately three years. No cracking or other defects were observed.[162/] Ultrasonic, dye-penetrant and visual examinations were performed on the spent fuel pool cooling system. No evidence of stress corrosion cracking was observed.[163/] Electrochemical Potentiokinetic Reactivation (EPR) tests were performed on representative weld locations of the Zion fuel storage racks at the manufacturers plant. These EPR tests for sensitization show that the values obtained for components of the Zion fuel storage racks are well within the range for safe behavior.[164/] The carbon content of the type 304 stainless steel in the Zion spent fuel racks is below the level at which intergranular stress

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161/ Licensee's Response to Board's Memorandum and Order, November 16, 1979 at p. 2.

162/ Affidavit of Thomas W. Lukens, October 17, 1979 at pp. 1-2.

163/ Affidavit of Robert Shannon, November 6, 1979 at pp. 1-3.

164/ Affidavit of Willis Lloyd Clarke, Jr., November 2, 1979; Affidavit of Staehle, November 16, 1979 at pp. 8-9.

stress in the proposed spent fuel racks.[165] Therefore, the Board finds that intergranular stress corrosion cracking is not likely to occur in the proposed fuel storage racks.[166]

The Board questioned whether the Applicant's commitment to conduct a corrosion surveillance program should be formalized as a technical specification in view of the need to maintain the program over a long period of time. The Staff testified that it has no plans to impose a technical specification on this subject, but that it will record the Applicant's commitment to follow this surveillance program in the cover letter which will accompany the issuance of any license amendment issued in this case. Further, the NRC's Office of Inspection and Enforcement does keep track of licensee commitments so

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165/ The Board concentrated on the possible impact of intergranular stress corrosion cracking on the fuel storage racks, because of the possible effect on maintaining fuel subcriticality, if the racks were to fail. Although stagnant, oxygenated, borated water may occur in the spent fuel pool cooling system piping, the Board finds this not to be a major problem. As indicated earlier in this decision, the system is redundant, making repairs possible without interrupting normal cooling. No pipe break can result in draining of the pool. Further, recent ultrasonic, dye-penetrant and visual examinations of the system revealed no evidence of intergranular stress corrosion cracking.

166/ The Applicant commits itself to supplementing its corrosion surveillance program by suspending ten specimens containing weld geometries and material similar to those in the fuel racks. The ten specimens are to be suspended adjacent to the proposed fuel racks and examined visually and ultrasonically on a yearly basis. Affidavit of Staehle, November 16, 1979 at p. 12; Licensee's Response to Board's Memorandum and Order, November 16, 1979 at p. 2.

listed and can and does enforce them.[167] Following careful consideration of this issue, the Board finds that the corrosion surveillance program need not be made the subject of a technical specification or condition of license. The corrosion surveillance program is a prudent measure to employ, but it has not been shown to have an immediate bearing upon the public health and safety. Support for this position is found in the decision in the Trojan case.[168] In arriving at the instant decision, it is the Board's recommendation, however, that the Applicant should not be relieved of this commitment without careful review by the Staff based on the facts at that time.

The Board finds that the corrosion surveillance program committed to by the Applicant is adequate to detect the loss of neutron absorber material and/or swelling of the storage tubes.

167/ Tr. 1972-73, 1983-85.

168/ In the Matter of Portland General Electric Company (Trojan Nuclear Plant), ALAB-531, 9 NRC 263, at 271, 277-278 (1979).

The Board finds that the Applicant and Staff have analyzed the long-term electrolytic corrosion effects of using dissimilar alloys and that the anticipated effects are not expected to be significant.

The Board finds that the Applicant and Staff have analyzed the proposed modifications and long-term storage effects on the stored fuel of accelerated corrosion, micro-structural changes, alterations in mechanical properties, stress corrosion and hydrogen absorption and precipitation by the zirconium alloys. Further, the Board finds that based on these analyses the effects are not expected to be significant.

The Board finds that the Applicant and Staff have adequately analyzed the corrosion rate of the fuel storage tubes, the effect of water chemistry on the Boral and the possible swelling of the stainless steel tubes.

The Board finds that adequate consideration has been given to the possible degeneration of the Boral density on the fuel storage tubes. The Board finds that the corrosion surveillance program to which the Applicant has committed itself, is adequate to detect significant loss or shifting in location of Boral. Therefore, the Board finds that the risk of criticality in the spent fuel pool from this effect is negligible.

F. Quality Assurance

Contention 2(k) states:

> The amendment request and supporting documentation do not consider possible degeneration of the Boral density due either to generic defects or to mechanical failure which would diminish the effectiveness of Boral as neutron absorber, thus leading to criticality in the spent fuel pool.

Contention 2(l) states:

> The Applicant has not described the procedures it intends to employ to prevent the installation and use of damaged and defective racks.

The quality assurance and quality control procedures of Commonwealth Edison, Brooks and Perkins (fuel storage tube manufacturer) and Leckenby (fuel storage rack fabricator) were described. These are designed to prevent the installation of racks with insufficient Boral density or other defects into the spent fuel pool.[169]

The boron carbide and other materials used by Brooks and Perkins to manufacture the Boral plates are certified by the supplier to meet applicable ASTM[170] standards. The certification documents are traceable to specific lot numbers of the boron carbide and reviewed by Brooks and Perkins quality assurance personnel. As an additional check, a sample of each lot is sent to Isotopic Analysis, Inc. to verify the boron-10 content

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169/ Testimony of Walter J. Shewski (Shewski) at pp. 1-10 following Tr. 707; Leider at pp. 10-12; NRC Staff Testimony on Contention 2(l) by Joel E. Kohler (Kohler) at pp. 1-4 following Tr. 786; Almeter and Lantz at pp. 13-15.

170/ American Society for Testing and Materials.

of the boron carbide powder by means of isotopic analysis. These steps are documented by Brooks and Perkins, and reviewed by Nuclear Services Corporation (NSC). Only upon a finding of adequate compliance with these procedures will NSC authorize use of the boron carbide powder for fabrication. The boron carbide is then used in the fabrication of Boral plates. A sample is taken from each end of the Boral plates and 10 percent of these samples are chemically analyzed for boron-10 loading by Brooks and Perkins.[171/]

The Boral sample is dissolved, the boron carbide filtered out and then dried and weighed. Because the isotopic content of the boron carbide is known through previous isotopic analysis of each batch of boron carbide, the boron-10 loading of the sample can be calculated by measuring the weight of the boron carbide which was separated from the Boral plate. The precision of the test is 0.0003 grams per square centimeter of boron-10.[172/]

Brooks and Perkins then forwards the test results to NSC for review, and upon a finding by NSC that these procedures have been adequately complied with, the tubes are released to Leckenby for rack fabrication.[173/]

171/ Shewski at pp. 5-7.

172/ Tr. 1040, 1940-41.

173/ Shewski at pp. 6-8.

The Applicant has retained NSC to perform independent inspections of Brooks and Perkins' fabrication of the fuel storage tubes. NSC inspectors review Brooks and Perkins documentation on a random basis while on inspection visits. However, all documentation is required to be sent to NSC headquarters for review.[174/]

In addition to review by Brooks and Perkins and NSC quality assurance personnel, Commonwealth Edison performs independent reviews, inspections and audits of the tube manufacturing process to ensure that there is adequate density of boron-10 in the Boral plates. As of the date of the hearings, there had been three audits of Brooks and Perkins conducted by Commonwealth Edison quality assurance personnel.[175/]

During the course of cross-examination, Intervenor introduced two letters pertaining to shipments from Brooks and Perkins to Leckenby of tubes which contained insufficient boron-10 content.[176/] Applicant's witness confirmed that five nonconforming tubes had in fact been shipped to Leckenby, and that the boron content of those tubes was 0.0189, 0.0189, 0.0186, 0.0196 and 0.0182 gm/cm^2. The minimum required boron-10 concentration is specified as 0.0200 gm/cm^2. This deficiency was not

174/ Tr. 718-720.

175/ Tr. 720-723.

176/ Intervenor's Exs. 2 and 3.

discovered in the April audit of Brooks and Perkins (the non-conforming tubes had been shipped in March), but was discovered in the June audit by the Applicant. None of the defective tubes had been used in the fabrication of the racks, and each tube had been tagged as defective and isolated to insure it would not be used.[177/]

Intervenor pointed out during its cross-examination of Applicant's witness that the Applicant first ordered the Boral containing tubes for the new Zion racks in July 1978. The original purchase order did not specify that the fabrication of the tubes was "safety-related". Therefore, the Brooks and Perkins quality assurance program was not required to conform to 10 CFR Part 50, Appendix B. The Applicant subsequently determined that this was incorrect judgment on its part and in November 1978 required that the fabrication of the tubes be safety-related. Applicant has not required that the suppliers of the component parts of the tubes have quality assurance programs conforming to 10 CFR Part 50, Appendix B. However, material supplied to Brooks and Perkins has to be certified to meet ASTM requirements. Brooks and Perkins and NSC personnel review the documentation to verify that the materials meet the ASTM requirements prior to their use.[178/]

177/ Tr. 736, 740, 745-748, 755.

178/ Shewski at pp. 5-6; Tr. 737-739.

Prior to releasing the completed racks for shipment to Zion Station, NSC is required to review and accept Leckenby's quality assurance inspection and review. Upon receipt of the racks at Zion, the Applicant's on-site quality control and quality assurance personnel are required to perform a receipt inspection for shipment damage and other possible defects. Furthermore, quality assurance personnel will be required to review the documentation to assure compliance of the materials and fabrication requirements. Written procedures detailing these inspections were received in evidence as Applicant's Exhibit Number 1.[179]

As part of the receipt inspection, a dummy fuel assembly built to exactly the same dimensions and tolerances as the fuel stored at Zion will be lowered into and raised out of each tube in the absorber rack. The Applicant will use a 20-pound drag criterion for determining the existence of a defect in the physical contours of any tube. Past experience shows that the 20-pound drag is the friction force that the dummy assembly will exhibit in being lifted and lowered into a rack.[180]

Under questioning by the Board, Applicant's witness indicated that the effective multiplication factor (K-effective)

179/ Shewski at pp. 8-9; Tr. 1939.

180/ Leider at pp. 11-12; Tr. 762.

for the proposed fuel storage configuration would not meet the Staff's criterion that it be less than 0.95 if one Boral plate out of sixteen (every four tubes) were missing. He indicated that this would also be true if only one out of thirty-two Boral plates were missing. The witness concluded that it is very important to know whether there are missing Boral plates in the racks before these racks are installed or utilized.181/

After the racks are installed in the pool, but prior to placing spent fuel therein, neutron attenuation tests will be performed by National Nuclear Corporation to confirm that there is a Boral plate in each of the four walls of the individual tubes tested. The tests will not be performed on every tube. However, these tests will be statistically designed to prove within a 95 percent confidence level that the four plates are present in each tube. The test is capable of establishing within 20 percent accuracy the boron-10 loading of each plate with 100 percent confidence.182/

On cross-examination by Intervenor, Applicant's witness testified that even though the tests will be conducted while the tubes are immersed in a boric acid aqueous solution, this will not mask any deficiency in the Boral. This is because the test will be calibrated to take into account the boric acid concentration

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181/ Tr. 1726-1741.

182/ Shewski at p. 9, Tr. 1942-1947, 2010.

in the fuel pool water.[183] In response to Board questioning the Staff indicated that it will require a commitment on the part of the Applicant to conduct neutron attenuation tests which could assure with a 95 percent confidence level that the Boral plates are present such that a K-effective of 0.95 would not be exceeded.[184]

In response to questioning by the Board, Applicant's witness stated that in the unlikely event it is discovered that a Boral plate is missing in any tube, the Applicant's commitment is to physically plug that tube to prevent the inadvertent insertion of a fuel assembly therein. Moreover, the Applicant will require that 100 percent of the remaining tubes be examined by means of neutron attenuation testing.[185]

Throughout the receipt, inspection, installation of the racks and subsequent neutron attenuation testing, the Staff will conduct inspections and reviews to assure that only conforming racks are installed in the pool. The NRC Region III Office of Inspection and Enforcement plans to utilize additional construction inspections during the proposed rack installation. Furthermore, if it is determined that the Applicant is improperly installing or handling the racks, stop-work orders will be issued expeditiously.[186]

183/ Tr. 1944, 1950.

184/ Tr. 1984, 1987-1990, 1993-1996.

185/ Tr. 1947-1948, 1950.

186/ Tr. 798-799, 802-804.

During the course of cross-examination of the Applicant's witness on criticality, the Board inquired as to how much boron in the Boral could be lost before K-effective would reach a level of 0.95. In response, the witness stated that roughly 75 percent of the boron in each plate could be lost, without reaching 0.95. The witness explained that 0.95 is an arbitrary number specified by the NRC's Standard Review Plan to assure that a criticality event cannot take place. Any value of K-effective less than 1.0 would ensure maintaining sub-criticality. Further, the calculations do not take credit for fuel burn-up, fission product poisoning, borated fuel pool water, or presence of any control rods. However, they assume no plutonium-239 or 241 in the fuel.[187]

Of particular concern to the Board is assurance that the boron-10 in the Boral plates will be in place and remain in place within the fuel storage tubes throughout the life of the station or throughout the use of the racks.

The Board finds that the quality assurance and quality control procedures described by the Applicant and Staff will ensure that the Boral will initially contain sufficient boron-10, and that the tubes and racks will be properly manufactured and installed in the pool.

187/ Tr. 1726, 1730-1731.

The Applicant has made a commitment to conduct neutron attenuation tests, to examine 100 percent of the tubes if the neutron attenuation tests reveal one missing Boral plate and to physically plug any tube found which has less than the prescribed number of Boral plates, or to take whatever other remedial action prescribed at that time by the Staff. The Board finds that the *in situ* neutron attenuation test is a key aspect of the quality assurance program to verify that the tubes and racks as installed do indeed contain a sufficient number of Boral plates that K-effective will not be greater than 0.95 when the fuel is in place in the tubes.

The Board has already found that the corrosion surveillance program committed to by the Applicant is sufficient to detect significant loss or shifting in location of the Boral.

G. Board Questions

In the Order Following Prehearing Conference dated 19 January 1979, the Board propounded a set of six questions [4(a) through 4(f)] to each of the parties, with the request that evidentiary showings on each of the questions be made at the public hearing.

1. Risk of Theft and Sabotage

Board Question 4(a) states:

> Will the proposed modifications of the spent fuel pool and/or the operation of the Zion station with increased spent fuel pool storage capacity:
>
> (1) increase the potential risk of threats to special nuclear material or to Station facilities?
>
> (2) increase the potential risk of theft of special nuclear material from the Station?
>
> (3) increase the potential risk of industrial sabotage to the Station or to the special nuclear material?
>
> (4) decrease the level of physical protection of the facilities or special nuclear material at the Station?

Board Question 4(b) states:

> As a result of the proposed modification of the spent fuel pool and the proposed operation of the Station with increased spent fuel storage capacity, will it be necessary to modify the Physical Security Plan, Safeguards Contingency Plan or the Emergency Plan for the Station? 188/

188/ The portion of Board Question 4(b) pertaining to the Station Emergency Plan is discussed in the next section of this decision.

During the course of cross-examination of Applicant's witness by Intervenor, a question arose concerning the interpretation of Question 4(a)(3). The Board stated that it had meant the parties to address only the likelihood or probability of industrial sabotage. The Board explained that it had not intended to direct the parties to explore the possible consequences of a successful act of sabotage.189/

The Applicant's Security Plan and Safeguards Contingency Plan were described in detail. Because the Zion security program is already designed to meet the general performance requirements of 10 CFR § 73.55, there would be no increased risk to special nuclear material or to the Station as a result of on-site construction activities. Furthermore, because the same degree of protection applies to the Zion spent fuel pool regardless of the number of spent fuel assemblies stored therein, there would be no increased risk as a result of the operation of the Station with increased spent fuel storage capacity.190/

The Commission's regulations pertaining to security do not require that licensees design their security programs to prevent theft of spent fuel. This is because the nature of spent

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189/ Tr. 2023-2024.

190/ Testimony of Larry B. Bean (Bean) at pp. 1-10 following Tr. 2019; NRC Staff Testimony on Board Questions 4(a) and 4(b) by Dean M. Kunihiro (Kunihiro) at p. 1 following Tr. 2036.

fuel makes it an unattractive target for theft. However, the features of the Station Security Plan designed to prevent sabotage should be adequate to protect against the risk of theft.[191/]

The modification and/or subsequent operation of Zion Station will not increase the potential risk of industrial sabotage to the Station or special nuclear material. The level of risk which the Applicant must protect against is defined in 10 CFR § 73.55(a), and this defined risk is not changed by the proposed modification and/or subsequent operation. The risk defined in § 73.55(a) is not dependent upon the number of stored fuel assemblies.[192/]

There will be no decrease in the level of physical protection, because the security program is designed to handle construction activities such as the proposed modification, and because the degree of physical protection relating to the spent fuel pool is independent of the number of fuel assemblies stored therein.

It will not be necessary to modify the Security Plan or Safeguards Contingency Plan because of the proposed modification and/or subsequent operation. The proposed modification

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191/ Bean at p. 11; Kunih[illegible] 2.

192/ Bean at p. 11; Kunihiro at p. 2.

will not permit the Applicant to store material different from that presently stored in the pool and the level of security protection required is independent of the quantity of irradiated fuel contained in the pool.[193/]

All company employees and contractors are subject to physical searches prior to entering a protected area. Each individual entering a protected area is screened by means of metal and explosive detection equipment. In addition, the Applicant's non-site assigned employees and contractors' employees are physically searched on a random basis. Applicant's regular Station employees are not physically searched.[194/]

The Board inquired as to whether the Applicant or the Staff had considered special nuclear material other than spent fuel (as intended by the Board) in preparing their written testimony. The witnesses responded that they had not previously considered material other than spent fuel, but that the conclusions stated in their prepared testimony were equally applicable to such material.[195/]

The Board finds, based on the evidence presented, that the proposed modification and subsequent operation of

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193/ Bean at p. 12; Kunihiro at pp. 2-3.

194/ Bean at p. 7; Tr. 2027-28.

195/ Tr. 2028-30, 2038-39.

Zion Station with increased spent fuel storage capacity will not increase the potential risk of threats, theft, or industrial sabotage to special nuclear material or to Station facilities. Further, the Board finds that there will not be a decrease in the level of physical protection of the facilities or special nuclear material at the Station and that there is no reason to modify the Safeguard Contingency Plan or Security Plan for the Zion Station. These findings are based, in large measure, upon our belief that the degree and type of physical protection afforded to the Station's protected areas is independent of the amount of spent fuel stored at the Station.

2. <u>Modifications to the Emergency Plan</u>

A portion of Board Question 4(b) pertains to whether it will be necessary to modify the Emergency Plan, as a result of the proposed modification and the proposed operation of the Station with increased spent fuel storage capacity.

A detailed explanation of the Applicant's Generating Station Emergency Plan (GSEP) was provided which included a description of the different emergency response classifications, the corporate emergency response structure and facilities, and a description of the Applicant's training and practice drills. The proposed modification or subsequent operation of the Station

will not require a change to the GSEP, since the GSEP is designed to provide an appropriate response to a continuum of possible accidents and is not predicated upon a particular amount of nuclear fuel in use or in storage at the facility, or tied to specific accidents or equipment malfunctions.[196/]

The Board finds that there is no need to change the Applicant's Emergency Plan due to the proposed modification and subsequent operation of Zion Station with increased spent fuel storage capacity.

3. Changes in Accidents Postulated in Previous Licensing Reviews

Board Questions 4(c), 4(d), 4(e) and 4(f) state:

(c) What postulated accidents, which might affect the safety of plant operating personnel in the spent fuel storage building or which might result in the release of radiation or radioactive materials from the spent fuel storage building, were specifically analyzed in the FSAR, SER, ER and FES utilized in the CP and OL licensing reviews of Zion Units 1 and 2?

(d) Which, if any, of the postulated accidents in (c), above, will be increased in probability, magnitude or consequence (to personnel, to the general public or to the environment) if the proposed spent fuel pool modifications are carried out?

(e) What provisions have been made or procedures developed to protect the workmen and/or plant personnel from the consequences of such postulated accidents during the period when the proposed spent fuel pool modifications are being performed?

196/ Testimony of Denton Louis Peoples (Peoples) at pp. 1-15 following Tr. 2044; Supplemental testimony of John R. Sears on Board Question 4(b) Emergency Planning (Sears) at p. 3 following Tr. 2053.

(f) Which, if any, of the postulated accidents in (c), above, will be increased in probability, magnitude or consequence (to personnel, to the general public or to the environment) as a result of the completion of the proposed spent fuel pool modifications and the proposed subsequent usage of the increased spent fuel storage capacity.

Nine postulated accidents were specifically analyzed in the FSAR, SER, ER and FES utilized in the CP and OL licensing reviews of Zion Station Units 1 and 2 which might affect the safety of plant operating personnel in the spent fuel storage building or which might result in the release of radiation or radioactive materials from the spent fuel storage building. These are (1) the fuel handling accident; (2) accidents resulting from earthquakes; (3) tornado related accidents; (4) spent fuel cask drop accidents; (5) spent fuel pool cooling system malfunction; (6) malfunctions in other parts of the plant; (7) loss of AC power; (8) leakage of radioactive fluids; and (9) drop of a heavy object onto a fuel rack.[197/]

The proposed modification will necessitate additional fuel moves. Therefore, the likelihood, and corresponding risk of a fuel drop accident will increase slightly. However, the incremental risk will be minimal since the number of fuel moves necessary to accomplish the modification will add less than one percent to the total number of fuel moves which will be

197/ Tramm at pp. 25-31; NRC Staff Testimony in Response to Board Questions 4(c), 4(d), and 4(f) by Jack Donohew and John J. Zudans (Donohew and Zudans) at p. 2 following Tr. 1999.

accomplished during the Station's lifetime. The fuel which will be moved during the modification will have decayed at least one month prior to being moved, which will decrease the magnitude or consequences of the postulated fuel handling accident by a factor of ten compared to freshly discharged fuel because of significant radioactive decay of the gaseous fission products contained in the fuel.[198/]

The Staff has under way a generic review of load handling operations in the vicinity of spent fuel pools to determine the likelihood of a heavy load impacting fuel in the pool and, if necessary, the radiological consequences of such an event. Until a review of the radiological consequences of a cask drop accident is completed, a shipping cask will not be permitted near the pool.[199/]

There will be no significant increased risk to personnel, the general public or the environment from the remaining accidents considered as a result of the modification and/or operation of the Zion Station with subsequent increased spent fuel storage capacity.[200/]

The Zion Station Emergency Operation Procedure Number 6 (EOP-6) outlines the actions required in the event

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198/ Tramm at p. 27; Donohew and Zudans at p. 3.

199/ Donohew and Zudans at p. 7.

200/ Tramm at pp. 25-33; Donohew and Zudans at pp. 2-9.

a fuel assembly is damaged or specific monitors indicate high radiation levels in the spent fuel pool area.201/

The Board finds that EOP-6 actions would adequately protect workmen and/or plant personnel from the consequences of postulated accidents during the period when the proposed spent fuel pool modifications are being performed.

The Board finds that the risks associated with a fuel handling accident during the period of the proposed fuel pool modifications will be less than those considered at the operating license stage. The Applicant will not receive permission to utilize a shipping cask within the vicinity of the spent fuel pool until such time as the Staff has completed its review and evaluation of the potential radiological consequences of a shipping cask falling into the pool. Therefore, the proposed modification does not alter the risk of a cask drop accident. The Board finds that there is no reasonable basis for believing that the risks of the other postulated accidents identified in response to Question 4(c) would be increased significantly as a result of the modification and/or subsequent operation of Zion Station.

201/ Leider at pp. 12-13 and Attachment A; NRC Staff Testimony on Board Question 4(e) by Joel E. Kohler (Kohler) at pp. 1-2 following Tr. 2000.

4. Design and/or Engineered Safeguards to Decrease Likelihood of Severe Pool Drainage Accident

In addition to the questions posed by the Board following the Prehearing Conference, the Board posed five additional questions to the parties during the evidentiary hearing following the limited appearance statements[202/]

Board Question 4(g) states:

> The Applicant and Staff are asked to describe any design and/or engineered safety features incorporated in the Zion spent fuel storage pool to decrease the likelihood of a severe pool drainage accident.

The spent fuel pool, including the pool cooling system, is designed as a Seismic Class I structure. The foundation of the pool is directly in the ground and is completely surrounded by earth. The pool is lined with 3/16ths-inch welded stainless steel and is provided with leak channels embedded in the concrete to collect and carry off to the radwaste system any water which should leak through the liner. Additionally, the bottom of the pool is reinforced in the shipping cask loading area to withstand a drop of a cask. Fuel casks are handled with a Seismic Class I designed overhead crane which is interlocked to prevent the carrying of a cask over the fuel in storage in the pool. Fuel assemblies are handled with a Seismic Class I designed bridge crane which

202/ Tr. 574-577.

travels above the pool. The fuel pool building is also a Seismic Class I design, to withstand tornado loadings and tornado driven missiles.

The walls of the spent fuel pool are approximately six feet thick concrete and the floor of the pool varies in thickness from three and one-half feet to nine feet. Furthermore, the base mat for the pool is about seven feet thick. The exterior of the concrete walls and floor is covered by a protective waterproof coating. The massive failure of the spent fuel pool structure is not considered to be a credible event.[203/]

The normal supply of makeup water for the spent fuel pool is from the demineralized flushing water system which can add water at about 200 gallons per minute. Also, water could be added directly to the spent fuel cooling system loops from the refueling water storage tank through permanently installed piping. Approximately 100 to 250 gallons per minute could be supplied in this manner. Further, fire hoses which exist in the spent fuel pool area and the auxiliary building are connected to electric and diesel fire pumps in the Seismic Category I crib house structure. This system could be used to supply at least 1,000 gallons per minute to the pool. In

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203/ Tr. 1028-30, 1035-36, 1854-56, 1865.

addition to these three sources of water which are permanently installed, hoses could be hooked up to draw water from the primary water storage tank, the secondary water storage tank, and the service water supply system. Of these the service water system is a Seismic Category I source of water which has its own independent pumps.204/

The Board finds that there are adequate design and engineered safety features incorporated into the Zion Station spent fuel pool which would reduce the likelihood of a severe pool drainage accident. The Board finds that these features should preclude the possibility of a severe drainage accident in the Zion Station fuel pool.

5. Pool Liner Leak

Board Question 4(h) states:

> The Applicant and Staff are asked to provide a history of the apparent leak in the liner of the spent fuel pool. Specifically, the following should be addressed:
>
> (1) Has the leak intensified with time?
>
> (2) What is being done with the water leaking from the pool?
>
> (3) Are there any technical specifications which limit the permitted leakage rate?
>
> (4) Why has the leak not been repaired?

204/ Tr. 1032-35.

(5) How will possible future leaks be located and repaired if the proposed increase in storage capacity is permitted?

When the Zion fuel pool was originally tested, several leaks in the vertical welds of the stainless steel liner were discovered which were subsequently repaired. The Applicant established a maximum permissible leakage rate of 50 gallons per day. Since the commencement of operation of Zion Station in 1973, the amount of make up water put into the pool has been a constant 20 gallons per day. This make up rate represents the amount of water lost through evaporation, water removed from the pool during changing of filter and demineralizer bed, transfer of the bed from pool cooling to refueling water storage tank cleaning, as well as leakage through the liner. Most of the water loss appears to be through evaporation. During the first week of the hearings, a three day sampling test was conducted and it was determined that the water so collected from the fuel pool was approximately a quart a day. The leakage goes through the leak-off lines into the drain collection tank and is handled as normal radwaste water. There are no technical specifications which limit the permitted leakage rate from the spent fuel pool.205/

State of the art leakage detection devices can locate a 0.005 gallon per minute leak. Such a leak would result

205/ Tr. 588, 1921-22, 1926-29.

in an excess of seven gallons per day total leakage. Therefore, it is difficult to locate a leak such as the Zion fuel pool leak.

There are several methods by which possible future leaks could be located and repaired if the proposed increase in storage capacity is permitted. First, the Applicant could attempt to eliminate other possible leakage pathways. This would entail the checking of drains, pumps, seals, valves, and heat exchangers. Secondly, in order to eliminate leakage pathways from the top of the pool liner, the water level of the pool could be decreased somewhat without endangering workers in the fuel pool area. If the leak had still not been located, a diver could be sent into the pool to inspect the seam welds in the liner by means of a vacuum box. This might necessitate the shuffling of fuel and/or the removal of racks to permit sufficient clearance for inspection by the diver. If reshuffling were not possible because of the amount of fuel stored in the pool, fuel could be temporarily stored in shipping casks or in the containment cavity. Once located, the liner could be welded as it was following the preoperational testing of the spent fuel pool.[206]

The Board finds that the amount of water that is currently leaking from the Zion spent fuel pool is negligible and does not represent a significant safety or environmental concern.

206/ Tr. 1923-25, 1928-29, 1993.

6. Component Cooling System Leak

Board Question 4(i) states:

> The Applicant and Staff are asked to address the contention made during limited appearance statements that the component cooling system has had a number of leaks which have not been repaired.

The component cooling system consists of pumps, valves, piping and heat exchangers. By design, some of these components leak water at a rate of about 0.2 gallons per minutes through seals in rotating components such as pumps and valves. Leakage is detected by level changes in the component cooling system surge tank which is alarmed in the control room.

Early in 1978, Zion Station operating personnel noted that the leak rate had increased to approximately 0.4 gallons per minute. The leak was traced to one of three heat exchangers in the component cooling system. Due to difficulties in procuring the gaskets necessary to reassemble this heat exchanger, plant personnel did not repair the leak during the spring 1979 refueling outage as originally planned. The Applicant noted that it planned to perform this maintenance operation during the fall 1979 outage.

Water which leaks from the component cooling system flows to the service water system. The component cooling system is monitored for radioactivity, and no radioactivity has

been detected in that system. Even if the leakage rate were to increase, there would be no impairment in the ability of the plant to continue operation or to shut down.207/

On one occasion during the prior year or two, some boric acid had apparently leaked onto the component cooling system pumps from boric acid tanks located on the floor above. This did not affect the operability of the pumps and was subsequently cleaned up and maintained in a clean condition.208/

The Board finds that the component cooling system leak does not represent a threat to the proper functioning of the system, and thus is not an unresolved safety question which might affect the operation of the spent fuel pool cooling system.

7. Increased Fuel Burnup Tests

Board Question 4(j) states:

> The Applicant and Staff are asked to report on the increased fuel burnup tests from the standpoint of the extent to which these subsequent spent fuel assemblies have been considered in the various analyses performed as part of this proceeding.

On March 7, 1979, the Applicant was granted permission to subject four fuel assemblies to additional burnup in the Zion reactor. In studies which had been conducted with respect to fuel which had been exposed to a burnup of 38,000

207/ Tr. 1037-40.

208/ Tr. 805-09.

megawatt-days per metric ton peak rod average burnups, no unusual or unexpected changes in the properties of Zircaloy had been observed. Therefore, the fuel in question at Zion, which will be exposed to between 48,000 and 55,000 megawatt-days per metric ton burnup (bundle average), should not behave differently than the fuel which was the subject of the earlier studies in terms of the effects on the Zircaloy cladding.[209/]

Because of U-235 depletion, the decay heat associated with the high burnup fuel will be approximately 9 percent lower for the first year of storage than fuel subject to normal burnup. After about one year of storage the high burnup assemblies will have a slightly higher decay heat rate than normal burnup fuel stored for an equivalent length of time because of longer lived isotopes present. However, on balance the decay heat from high burnup assemblies will be lower than that from normal burnup fuel.

Approximately 25 percent more longer-lived isotopes can be expected in the high burnup fuel assemblies than in normal burnup fuel. However, the more volatile fission products have shorter half-lives, in general. Therefore, the consequences of a drop accident involving a higher burnup assembly would be lower for high burnup fuel because of lower power densities due to U-235 depletion. Therefore, the probability of a

209/ Tr. 1276-80, 1802-07.

radioactive release from leaking higher burnup assemblies would be lower than for normal assemblies.[210]

The Board finds that the increased fuel burnup tests being conducted at the Zion Station do not increase the heat load on the spent fuel pool cooling system and do not increase the risks of radioactive releases from leaking fuel or from a fuel assembly drop accident in comparison to the conditions already considered as part of the amendment request.

8. Fuel Building and Groundwater Monitoring

Contention 2(e) states:

> 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 [inter alia]:
>
> (5) Procedures to monitor groundwater movement in the vicinity of the plant to detect leakage from the spent fuel pool.

Although the parties sought to withdraw this contention, the Board stated that it would like to hear evidence on this issue and directed the parties to consider this contention as a Board question.[211] Applicant's witness discussed groundwater monitoring at the Zion Station.[212]

210/ Tr. 1789-91, 1795-99.

211/ Tr. 730.

212/ Tr. 1005-1027

Applicant's radiological monitoring program was planned to serve two objectives:

> to determine background concentrations of radioactive materials in the Zion environment prior to plant startup (pre-operational studies), and subsequently to determine the radiological effects of plant operations on the environment (operational studies).212/

Included in the initial monitoring program were several groundwater samples and a sample of lakewater off State Park Lodge.213/

Applicant's witness testified that the routine environmental program for monitoring groundwater was conducted from 1970-1977 and consisted of monitoring three wells to the west of the site, with quarterly grab samples analyzed for gross alpha and gross beta activity.214/ Applicant's witness further stated that, at his suggestion,215/ Applicant "made a formal submittal to the NRC, requesting a change in the technical specifications", in part "to do away with the well water monitoring program."216/ The change also eliminated the collection of lakewater from the Lodge area.217/ Rationale for the

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212/ Final Environmental Statement Related to Operation of Zion Power Station, Units 1 and 2, Commonwealth Edison Company, Docket Nos. 50-295, 50-304, December 1972 (FES).

213/ Id., at V-33 and V-34; Final Safety Analysis Report § 2.8, Table 2.8.1.

214/ Tr. 1008.

215/ Tr. 1008.

216/ Tr. 1009.

217/ Tr. 1012.

change in technical specifications, which was implemented in November 1977, was that "the only wells that we had available to us were on the west side of the plant and groundwater in this area moves eastward" and "second, that there is no discharge to the groundwater from Zion Station or, really to my knowledge, from any other nuclear station."[218/] Not surprisingly, the "upgradient" samples that were taken between 1970-1977 failed to show any unusual level of radioactivity.[219/] Applicant's witness admitted that this program would not be capable of detecting any leakage from the plant into the surrounding groundwater.[220/] The existing monitoring program for detecting release of liquid radioactive effluents into the environment consists of sampling at the Station intake (2500 feet out into the lake), the Station discharges (700 feet out from shore), and six public water intakes, the closest being about a mile north of the plant.[221/] There are no groundwater monitoring wells on the Zion Station site itself, either upgradient or downgradient of the Station.[222/] Applicant's position is that the purpose of any groundwater monitoring would be to detect contamination of existing potable water supplies, rather than monitoring for possible contamination of groundwater from site activities.[223/]

218/ Tr. 1009; Tr. 1011.

219/ Tr. 1010-1011.

220/ Tr. 1011.

221/ Tr. 1012.

222/ Tr. 1013.

223/ Tr. 1016; Tr. 1017.

The Board finds that the issue of groundwater monitoring involves matters beyond the scope of this proceeding which is limited to matters related to potential impact of increasing the storage capacity of the spent fuel pool. We are not authorized to examine matters which were explored at the construction permit or operating stages, nor those which were resolved with subsequent amendments to the technical specifications.

However, the Board calls attention to certain unusual features of the Zion Station. Zion Station is uniquely situated in that its 250-acre site is within the city limits of the City of Zion, fronts on Lake Michigan, and is adjacent to a major park, Illinois Beach State Park, attracting over one million visitors per year.[224] The residential area of Zion is less than a mile from the site. The residential center of Zion is approximately 1.5 miles from the site.[225] The area is underlain by creviced dolomitic bedrock aquifers and water-yielding glacial deposits which are connected hydrologically; the geological structure is such that prevailing groundwater flow should be eastward (toward Lake Michigan).[226] The shoreline in the immediate vicinity features the only dunes in the state, "such a unique and special feature that the State of Illinois has set aside a 3-mile tract of shoreline and adjacent territory as a state park."[227]

224/ FES at II-10.

225/ FES at II-3.

226/ FES at II-5 and II-8.

227/ FES at II-9.

The Board further calls attention to the fact that the radiological monitoring system has never included groundwater monitoring in the immediate vicinity of the site and at the present time includes no groundwater monitoring at all. While the Board finds that the proposed modification will not in itself increase the environmental impact of the Station, we find no basis for determining whether the present SFP or the Station as a whole has had any effect on the groundwater in the vicinity. We further note that a current Regulatory Guide points out the importance of groundwater monitoring in the vicinity of spent fuel storage pools.[228/]

228/ Regulatory Guide 3.44, "Standard Format and Content for the Safety Analysis Report to be Included in a License Application for the Storage of Spent Fuels in an Independent Spent Fuel Storage Installation (Water-Basin Type)", December 1978, § 2.5.

III. CONCLUSIONS OF LAW

The Board has reviewed the evidence submitted by all parties in regard to Intervenor's contentions, and in response to the Board's own questions. The Board has also considered the proposed findings of fact and conclusions of law submitted by the parties. Those proposed findings of fact and conclusions of law not adopted herein by the Board are rejected. The Board makes the following conclusions of law:

(1) The issuance of the license amendment requested in this proceeding is not a major Commission action significantly affecting the quality of the human environment and therefore it does not require the preparation of an environmental impact statement under the National Environmental Policy Act of 1969, 42 U.S.C. § 4321, et seq., and Part 51 of the Commission's regulations, 10 CFR Part 51.

(2) The Commission's "Notice of Intent to Prepare Generic Environmental Impact Statement on Handling and Storage of Spent Light Water Power Reactor Fuel", 40 Fed. Reg. 42801 (September 16, 1975), does not prohibit non-emergency licensing actions designed to ameliorate a possible shortage of spent fuel storage capacity prior to completion of the Generic Environmental Impact Statement. Portland General Electric Company (Trojan Nuclear Plant), ALAB-531, 9 NRC 263 (1979). The Board has applied the five factors mentioned in the Commission's Notice of Intent and concludes that they favor issuance of the requested license amendment at this time.

(3) The Board finds that the proposed action will not significantly affect the human environment. It therefore finds that it is not required by law to consider the alternatives of shutting down or curtailing the output of Zion Station.

(4) There is reasonable assurance that the activities authorized by the requested operating license amendments can be conducted without endangering the health and safety of the public provided that the conditions set forth in the order, below, are incorporated into the licenses.

(5) The activities authorized by the requested operating license amendments will be subject to compliance with the Commission's regulations.

(6) The issuance of the requested operating license amendments will not be inimicable to the common defense and security or to the health and safety of the public provided there is compliance with the conditions set forth in the order below.

IV. ORDER

Wherefore, it is ORDERED, in accordance with the Atomic Energy Act, as amended and the regulations of the Nuclear Regulatory Commission, and based on the findings and conclusions set forth herein, that the Director of Nuclear Reactor Regulation is authorized to make appropriate findings in accordance with the Commission's regulations and to issue the appropriate license amendment authorizing the requested replacement of spent fuel storage racks at Zion Station.

The aforementioned license amendment shall contain the following conditions:

(1) Fuel stored in the spent fuel pool shall have a U-235 loading less than or equal to 40.6 grams per axial centimeter.

(2) No loads heavier than the weight of a single spent fuel assembly plus the tool for moving that assembly shall be carried over fuel stored in the spent fuel pool. The spent fuel handling tool, the burnable poison tool, the rod cluster control changing fixture and the thimble plug shall not be carried at heights greater than two feet over fuel stored in the spent fuel pool.

The aforementioned license amendement takes into consideration the following commitments by the Applicant:

(1) Notification of the NRC in advance should it become necessary to handle heavy loads in the vicinity of the spent fuel storage pool.229/

(2) A corrosion surveillance program for the racks to insure that any loss of neutron absorber material and/or swelling of the storage tubes is detected.230/

229/ Supra, p. 24

230/ Supra, p. 63

(3) In situ neutron attenuation tests to verify that tubes and racks contain a sufficient number of Boral plates such that K-effective will not be greater than 0.95 when the spent fuel is in place.231/

The Board finds that these commitments by the Applicant add to the assurance of safe operation of the Spent Fuel Pool, and therefore they contribute to the Board's conclusion that the application to modify the Zion spent fuel pool should be granted. Accordingly, the Board finds as a matter of law that the Applicant is bound by these commitments and that failure to implement them is subject to any appropriate sanctions found in the Commission's regulations.

It is further ORDERED in accordance with 10 CFR §§2.760, 2.762, 2.764, 2.785, and 2.786, that this Initial Decision shall be effective immediately232/ and shall constitute the final action of the Commission forty-five (45) days after the issuance thereof, subject to any review pursuant to the above-cited Rules of Practice.

Exceptions to this Initial Decision may be filed within ten (10) days after service of this Initial Decision. A brief in support of the exceptions shall be filed within

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231/ Supra, p. 74

232/ This proceeding is not covered by the Commission's recent suspension of the immediate effectiveness rule (10 CFR §2.764) for certain purposes. 44 Fed Reg 65049 (November 9, 1979).

ATTACHMENT E

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION
HAROLD R. DENTON, DIRECTOR

In the Matter of COMMONWEALTH EDISON COMPANY (Zion Station, Units 1&2)	)	Docket Nos. 50-295 50-304 (10 CFR 2.206)

DIRECTOR'S DECISION UNDER 10 CFR 2.206

By letter dated April 27, 1979, Ms. Catherine Quigg, on behalf of Pollution and Environmental Problems, Inc. (PEPI), transmitted a request pursuant to 10 CFR 2.206 for the preparation of an environmental impact statement on high burnup fuel at Zion Station, Units 1 and 2. This request was predicated on the fact that on March 7, 1979, the Nuclear Regulatory Commission issued Amendments Nos. 44 and 41, respectively, to Facility Operating License Nos. DPR-39 and DPR-48. The amendments revise Technical Specifications for Zion Station, Units 1 and 2.[1/] These amendments would allow the reinsertion of a maximum of four fuel assemblies previously irradiated in Unit 1 for a maximum of two additional fuel cycles (beyond the normal three fuel cycles) in Unit 2 to gain operating experience for an anticipated future extended burnup program.

PEPI requested the preparation of an environmental impact statement to provide information which it thought the public needed because of the following factors associated with high burnup fuel:

1. greater fission gas releases from nuclear reactors;
2. increased fission gas releases from spent fuel pools due to increased corrosion;

1/ Amendments 44 and 41 are attached as Appendix A.

3. previous government research, based on "low burnup fuel" is useless in predicting the behavior of "high burnup fuel", and
4. potential for greater radiological impact in reactor and spent fuel pool accidents.

Consistent with the National Environmental Policy Act of 1969 (Public Law 91-190, 83 Stat. 852) and the Commission's regulations (10 CFR Part 51), an environmental impact statement 2/ was prepared at the operating license stage of Units 1 and 2. This statement addressed the range of environmental impacts associated with the operation of the Zion Station. However, an environmental impact statement is not required to be prepared for every license amendment. In this case, the Staff had prepared an environmental impact appraisal 3/ and negative declaration 4/ pursuant to 10 CFR 51.5 for the amendments, and had concluded that an EIS was not warranted because the action will not significantly affect the quality of the human environment. The negative declaration was published in the Federal Register on March 19, 1979, (44 FR 16504).

In the environmental impact appraisal, the Staff compared the fission gas release from the extended burnup fuel assemblies in the Unit 2 core to the releases from the other fuel assemblies in the core. It was noted that operating Unit 2

2/ Final Environmental Statement Related to Operation of Zion Nuclear Power Station Units 1 and 2, December 1972.

3/ Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation Supporting Amendment No. 44 to Facility Operating License No. DPR-39 and Amendment No. 41 to Facility Operating License No. DPR-48 dated March 7, 1979. The Appraisal is attached as Appendix B.

4/ Notice of Issuance of Amendments to Facility Operating Licenses and Negative Declaration dated March 7, 1979. The Notice is attached as Appendix C.

thirty (30) days thereafter [forty (40) days in the case of the Staff]. Within thirty (30) days of the filing and service of the brief of the Appellant [forty (40) days in the case of the Staff], any other party may file a brief in support of, or in opposition to, the exceptions.

IT IS SO ORDERED.

THE ATOMIC SAFETY AND
LICENSING BOARD

Linda W. Little, Member

Forrest J. Remick, Member

John F. Wolf, Chairman

Dated at Bethesda, Maryland,
this 14th day of February, 1980.