UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 50-155
CONSUMERS POWER COMPANY	)	
	)	(Spent Fuel Pool Modification)
(Big Rock Point Nuclear Power Plant)	)	

NRC STAFF PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW ON O'NEILL CONTENTION II.E-3

I. BACKGROUND

This is a decision on an application by Consumers Power Company (Licensee) to amend its operating license to modify its spent fuel storage pool at Big Rock Point Nuclear Power Plant. The application for amendment is contested by Christa-Maria et al. and John O'Neill (Intervenors) who have submitted a number of contentions opposing the proposed modification of the spent fuel pool. This decision is limited to subcontention II.E-3 of John O'Neill which deals with the possibility of criticality occuring in the spent fuel pool as a result of the increased density of storage of spent fuel. In its Memorandum and Order of February 5, 1982,[1/] the Board denied summary disposition of this contention, concluding that it raised a genuine issue of material fact.

1/ Memorandum and Order (Denying Summary Disposition of Criticality Contention), February 5, 1982.

II. O'NEILL CONTENTION II.E-3

O'Neill contention II E-3 states:

> The application has not adequately analyzed the possibility of criticality occurring in the fuel pool because of the increased density of storage without a gross distortion of the racks.

On January 29, 1982, Intervenor Crista-Maria submitted an argument opposing summary disposition of O'Neill Contention II E-3. The argument was not supported by any affidavits or documentary evidence. Nevertheless, the Board concluded in its Memorandum and Order of February 5, 1982, that the argument was basically correct and that it demonstrated the existence of a genuine issue of fact. The argument stated:

> Criticality analysis performed by Dr. Kim is based on a water temperature of 212°F, assuming boiling of the spent fuel pool, with the containment at atmospheric pressure. Even assuming that the containment is at atmospheric pressure (not necessarily conservative after a LOCA [loss of coolant accident]), the pressure at the bottom of the spent fuel pool, due to the hydrostatic load is 28.14 psia. The boiling temperature at that pressure is 247°F. Since the effective activity coefficient k is not permitted to exceed 0.95, and since Dr. Kim's calculations reached this maximum, assuming 212°F, it is questionable if the calculations can be considered conservative.

After a thorough review, the Board noted that Dr. Kim adopted the "conservative" assumption that water in the pool would boil at 212°F. Dr. Kim's most recent calculation, using that assumption, is that the $k_{effective}$ (k_{eff}) is .9500, which is the maximum allowable figure under existing Commission guidance. Standard Review Plan (NUREG-0800) p. 9.1.2-3 at § II(5) and Proposed Revision 2 to Regulatory Guide 1.13, p. 1.13-9 to 15 at § 1.2 (k_{eff} not to exceed 0.95).

III. STATEMENT OF APPLICABLE LAW

10 C.F.R. Section 50.57(a)(3)(i) and (ii) require reasonable assurance that the activity authorized by the operating license, specifically, the increased density of storage resulting from the proposed modification to the spent fuel pool at Big Rock Point, can be conducted without endangering the health and safety of the public.

IV. OPINION

Licensee presented testimony from witnesses Yong S. Kim, Daniel A. Prelewicz and Raymond Sacramo to address the concerns expressed by the Licensing Board on page 5 of its February 5, 1982 Memorandum and Order concerning potential criticality of the spent fuel pool. (Testimony of Kim, Prelewicz and Sacramo, ff. Tr. 1419, 1420, and 1421, respectively).

Dr. Kim, a registered engineer, has primary responsibility with NUS Corporation for reactor physics analyses, including criticality analyses of spent fuel storage racks. He addressed the concern of the Board regarding the potential occurrence of supercriticality in the spent fuel pool under certain conditions, expressed by the Board in its "Memorandum and Order" of February 19, 1982, at pp. 48-49. (Testimony of Yong S. Kim Concerning Criticality Analysis O'Neill Contention II E-3, ff. Tr. 1419 at p. 1, 2(Kim)). Dr. Kim discussed his method of analysis and concluded that the maximum k_{eff} calculated for the same conditions as the prior analysis except for thermal-hydraulic input is 0.9470. (Kim, pp.3-13) Any reduction in k_{eff} due to possible rack distortions under higher temperature is neglected in this result to be conservative. The value 0.9470 is below 0.95 and satisfies the NRC criteria regarding k_{eff} for

spent fuel pools. The other conservative assumptions such as fresh fuel, radial infinity, axial infinity, and others used in the original analysis are still applicable to this result. Also, the small steam voids which could be formed by the cooling system failure will not result in a super-critical condition. (Kim, p. 14).

Mr. Prelewicz, a registered mechanical engineer, provided consulting services in the areas of fluids systems and other areas involving nuclear safety. His testimony described both the natural circulation cooling process in the Big Rock Point spent fuel pool and the manner in which pool thermal conditions are determined. He provided Dr. Kim with a more realistic set of thermal conditions for use in the criticality analysis. (Testimony of Daniel A. Prelewicz Concerning Thermal Hydraulic Conditions for Criticality Analysis, ff. Tr. 1420, at pp. 1, 2(Prelewicz)). Based on the conditions supplied by Mr. Prelewicz, detailed calculations of the natural circulation flow patterns in the spent fuel pool were conducted with a GFLOW computer program (attached as Exhibit A to Testimony of Mr. Prelewicz, ff. Tr. 1420, p. 8). GFLOW models a representative section of the fuel pool in three dimensions and determines the velocity and temperature of water throughout the pool. The analysis verifies the assumption that water enters the bottom of the fuel racks at 212°F in the one-dimensional licensing analysis, and the temperatures of the water in the pool will not reach 247°F (Prelewicz, pp. 8, 9).

Mr. Raymond F. Sacramo presented testimony concerning the possible distortion of the spent fuel pool racks and the result of this on the K_{eff}. After reexamining two postulated fuel assembly drop cases, Mr. Sacramo confirmed the adequacy of the evaluation which appears on pages 5-8, 5-9, 5-10, and 4-7 of Revision 1 to Consumers Power Company's application, entitled "Consumers Power Company, Big Rock Point Spent Fuel Rack Addition, Consolidated Environmental Impact Evaluation and Description and Safety Analysis", dated April 1982.

In the first postulated cask drop case the stresses above the support plate in the active fuel length region, when combined with other design load conditions, would be below design allowables, and therefore, the center-to-center distance between the storage cans would be maintained. (Testimony of Raymond F. Sacramo Concerning Possible Distortion of the Spent Fuel Pool Racks, ff. Tr. 1421 at pp. 3, 4(Sacramo)).

With regard to the second postulated cask drop, the forces transmitted below the crushed area through the storage can side plates are well below those which would cause lateral distortions in the storage cans. As in the first impact case, local distortions to the rack would occur, but under both cases only small amounts of energy are transmitted to the active length stored fuel regions, resulting in no change in the rack geometry in these regions (Sacramo, p. 4).

Mr. Sacramo also discussed the effect of heat on the racks. By assuming a worst-case temperature differential of 167°, the result is a conservative increase in the center-to-center distance between stored fuel assemblies of approximately 0.015 inches over the nominal pitch of 9 inches (Sacramo, p. 5).

Based on Mr. Sacramo's testimony Dr. Kim was able to conclude that the drop of a fuel assembly on top of a fuel rack is not expected to cause any distortion of the rack along the length of the stored fuel assembly and, therefore, would not change the k_{eff} (Kim, pp. 9, 10).

On cross-examination, Dr. Kim explained the methodology used in his calculation of the k_{eff} (Tr. 1435-1468; 1503-1529). Dr. Kim explained the basis for changing voids (Tr. 1512, 1513) and other assumptions (Tr. 1514-1529). Following Dr. Kim's testimony, Intervenor cross-examined Dr. Prelewicz to determine what information he had supplied Dr. Kim (Tr. 1530-1570). Nothing disclosed on cross-examination, however, controverted the direct testimony of Dr. Kim.

On redirect examination, Dr. Prelewicz explained how the documents containing the information he used were kept and where they had been sent (Tr. 1570-1596). After Dr. Kim and Dr. Prelewicz were sequestered, counsel for Licensee established that Dr. Prelewicz did not read Dr. Kim's criticality analysis.[2/]

Following this, witnesses Kim, Prelewicz and Dr. Rodney R. Gay explained their methods of calculating and verifying the variables used in establishing pool boiling temperatures and the behavior and circulation of the water in the fuel pool at boiling temperatures (Tr. 1603-1684). Dr. Gay stated that if the surface temperature is 212 degrees and the

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2/ The Licensee's witnesses, Dr. Kim and Dr. Prelewicz, had been sequestered up to this state of the proceedings on criticality upon Intervenor's request. The Board noted that although the sequestration procedure may have placed in question the integrity of Dr. Kim and Dr. Prelewicz, there was nothing in the testimony that was presented which left any doubt about the integrity of these witnesses (Tr. 1602).

pool is fully loaded, there will be no boiling according to the predictions of the code (Tr. 1630).

On cross examination, Dr. Gay established that the GFLOW computer code had been used for Diablo Canyon in California (Tr. 1684-1685). Mr. Prelewicz stated that he knew of nothing dissolved in the water that would significantly affect the boiling point. (Tr. 1689). Mr. David P. Blanchard stated that filter socks would eliminate the iron oxide crud deposited from fueling operations (Tr. 1690).

On further redirect examination, Dr. Gay established that the input to the code that was used in the analysis was checked according to quality assurance procedures by an NUS employee. (Tr. 1756). Dr. Gay also stated that the predictions of the heat transfer in the experiments required an accuracy of ten percent from the warmest temperature in the pool to the coldest (Tr. 1758).

On examination by the Board Mr. Blanchard stated that he had read Dr. Kim's analysis of criticality and felt it was correct and conservative (Tr. 1819). Mr. Blanchard also stated that he had verified certain conditions of Dr. Kim's analysis of criticality (Tr. 1823). Dr. Kim stated in response to a Board question that, having reviewed the analyses performed by Dr. Prelewicz and Dr. Gay, he was satisfied with the overall design and the pool hydraulics (Tr. 1856).

NRC staff presented witnesses Richard L. Emch and Edward Lantz to address the possibility of criticality occuring in the spent fuel pool (Testimony of Edward Lantz Concerning O'Neill Contention No. II.E-3, ff. Tr. 1905 (Lantz); Testimony of Edward Lantz and Richard L. Emch Concerning Licensing Board Questions Dated May 13, 1982, ff. Tr. 1906 (Lantz/Emch)). Mr. Lantz stated in his conclusion that there will be no

criticality in the undistorted racks as long as the Technical Specification limit of 28.3 grams of uranium-235, or equivalent, per axial centimeter of fuel assembly installed in the racks is complied with (Lantz, p. 9).[3/] There was nothing in the geometry of the fuel pool, fuel elements or spent fuel storage racks that could substantially alter natural water convection currents (Lantz/Emch, p. 2). While there are credible accident scenarios whereby debris such as tools, coveralls, and other lightweight equipment could fall into the pool, these scenarios are quite unlikely (Lantz/Emch, p. 2). Any impediment to natural circulation will lead to higher temperature in the spent fuel pool and that this could cause, hypothetically, regions of local boiling in the spent fuel pool. (Lantz/Emch, p. 3). However, increasing or decreasing the boiling temperature of the water above or below 212°F with 1% void due to steam bubbles formed by boiling will reduce the k_{eff} because the water density will be less than optimum (Lantz/Emch, p. 3; Tr. 1913-15).

On redirect examination, Mr. Lantz testified that if the density of the pool water deviates from .948 the k_{eff} will decrease. Mr.Lantz stated he understood Dr. Kim's testimony to be consistent with his,[4/] emphasizing the primary importance which he had placed upon water density, rather than temperature, as being the primary determinant in the computation of k_{eff}. (Tr. 1935-36, 1947, 1973).

3/ Upon examination by the Board, Licensee's witness Blanchard confirmed the enrichment of the fuel to be 27.1 grams per axial centimeter (Tr. 2384).

4/ Dr. Kim acknowledged that his calculations of k_{eff} for pool water with a high steam void content, done with four-neutron group calculation, were somewhat inaccurate (Tr. 1951-52). With this acknowledgement, the testimonies of Dr. Kim and Mr. Lantz are consistent.

In response to questioning by the Board, Mr. Blanchard noted that the reactor deck usually has plastic sheets to cover contaminated areas. If there is some maintenance being performed in the reactor deck area there may be plastic bags or clothing in that area. However, with the ordinary rounds made by the operators on the reactor deck, these items would be readily detectable from the surface of the pool. (Tr. 2095-96).

On direct examination by Licensee, Mr. Blanchard noted that the plastic sheets were bright yellow to be visible compared with the background, and that the pool water itself was very clear, permitting visibility all the way to the bottom of the pool (Tr. 2098).

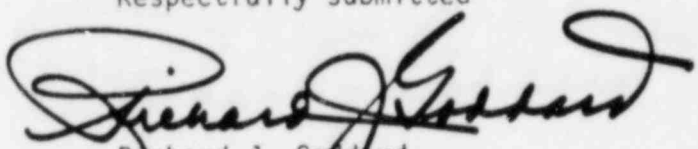
Counsel for Intervenor presented no evidence or testimony to controvert the testimony of witnesses for either the Licensee or Staff.

CONCLUSIONS OF LAW

Based on the foregoing reasons and the uncontroverted evidence of the Licensee and Staff, the Board finds as a matter of law that the application adequately analyzes the possibility of criticality occurring in the spent fuel pool of the increased density of storage without a gross distortion of the racks. Therefore, there is reasonable assurance that the activity authorized by the operating license, specifically, the proposed modification to the spent fuel pool at Big Rock Point can be conducted without the possibility of criticality occurring in the spent fuel pool and without endangering the health and

safety of the public, in accordance with the requirements of 10 C.F.R. Section 50.57(a)(3)(i) and (ii).

Respectfully submitted



Richard J. Goddard
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 1st day of October, 1982.