HELPING BUILD ARKANSAS

ARKANSAS POWER & LIGHT COMPANY

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May 5, 1975

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Mr. E. Morris Howard, Director
Office of Inspection and Enforcement
Region IV, Suite 1000
611 Ryan Plaza Drive
Arlington, Texas 76012

Subject: Arkansas Power & Light Company
Arkansas Nuclear One-Unit 2
Docket No. 50-368
NRC Control No. H00710F4
Significant Deficiency Report
Spent Fuel Pool Walls

Dear Mr. Howard:

On February 7, 1975, we submitted an interim report for the subject deficiency reported on January 9, 1975. Attached is our final report for the subject deficiency providing a description of the deficiency, analysis of the radiation safety implications and corrective actions taken.

Very truly yours,

J. D. Phillips
Senior Vice President

JDP:lt

Attachment

cc: Mr. Donald K. Knuth, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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STATE OF ARKANSAS )
) SS
COUNTY OF PULASKI )

J. D. Phillips, being duly sworn, states that he is a Senior Vice President of Arkansas Power & Light Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this Supplementary Information; that he has read all of the statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

J. D. Phillips

J. D. Phillips

SUBSCRIBED AND SWORN TO before me, a Notary Public in and for the County and State above named this 5th day of May, 1975.

Linda B. Thomas

Notary Public

My Commission Expires:

March 1, 1978

FINAL REPORT
SPENT FUEL POOL DESIGN

This report covers the design deficiency reported for the Arkansas Nuclear One-Unit 2 Spent Fuel Pool Walls. The report also covers the safety implications had the deficiency gone undetected as well as a description of the structural analysis and the reinforcement method to be employed.

1) Description of Deficiency

The horizontal reinforcing steel on the inside face of the spent fuel pool and the tilt pit is not properly detailed so as to develop the bars at points of high stress. This occurs at the junction of east-west wall with north-south wall. The horizontal reinforcing steel in these walls is bent to form a 90 degree bend on the inside face of the pool rather than extending through the wall to the outer face reinforcement to provide proper embedment length to develop the bars.

2) Analysis of the Radiation Safety Implications

In analyzing the safety implications of a postulated failure of the wall separating the spent fuel pool from the fuel tilt pit, the tilt pit was assumed to be completely dry prior to the failure. Additionally, it was conservatively assumed that the spent fuel racks are completely full, with 1/3 core loadings from five subsequent refuelings and 1 complete core which had decayed for only 7 days since reactor shutdown.

Following the postulated failure of the wall, the water levels in the tilt pit and the spent fuel pool would equalize, resulting in a decrease of the total height of water above the top of the active fuel from 26 feet to 19 feet. The resulting increase in the radiation dose rates at the operating deck near the edge of the pool would be insignificant. Since the normal pool level was selected to ensure that dose rates at the pool surface do not exceed 5 mrem/hr during refueling operations, the doses resulting from the wall failure would be less than the doses encountered when transferring spent fuel from the reactor vessel to the spent fuel racks.

The decrease in the pool level, however, would result in the loss of suction to the fuel pool cooling pumps and, consequently, the loss of the normal fuel pool cooling system. The fuel pool pumps would trip on low discharge pressure. Alarms in the Control Room would alert the Control Room Supervisor of the low pool level and the tripping of the cooling pumps. A valve line-up to supply makeup water to the pool would be promptly initiated. Makeup to the pool would be provided from the Refueling Water Tank via the fuel pool purification pump at the rate of approximately 150 gpm.

With this makeup rate pool level would be increased at the rate of approximately 1.3 ft/hr. Approximately 3.5 hours after loss of normal cooling, the water in the pool would begin to boil. The boiloff rate would be approximately 62 gpm. When this occurs, the rate of level increase in the pool as a result of adding makeup water at 150 gpm would decrease to approximately 0.54 ft/hr.

Since the spent fuel pool racks are designed to provide sufficient thermal circulation to prevent the fuel cladding from being damaged when boiling conditions exist in the pool, no significant release of fission products from the spent fuel to the atmosphere would occur as a result of the postulated wall failure. The spent fuel pool would be restored to its normal water level and normal cooling re-established within approximately 8.5 hours after the wall failure.

In conclusion, it has been determined that the postulated failure of this wall does not represent any hazard to the health and safety of the general public or to any plant operating personnel.

3) Corrective Action Taken

When the deficiency became known, a check of the structural design calculations was made to verify the design basis. The original design was based on a fixed condition at the intersection of the walls as well as at the base slab. Due to the manner in which the reinforcing was detailed, the critical wall intersection conditions changed from the fixed design condition to a hinged condition while the condition at the base slab remained as designed.

The spent fuel pool was reanalyzed using two separate computer programs.

The wall separating the fuel pool and tilt pit was first analyzed with three-dimensional brick elements using CDC computer program 3D/SAP, general structural analysis program. Three separate end conditions were used in this analysis. The first considered both vertical edges of the wall hinged with full hydrostatic load. The second considered that just the upper 10 feet of the separation wall was fixed with full hydrostatic load. The third considered both edges hinged and supported by a strut just to the east of the gate opening with full hydrostatic load. The first two analyses resulted in high transverse shear stresses around the bottom of the fuel pool gate opening and at the intersection with the west wall of the fuel pool. The third analysis indicated that depending on the stiffness of the strut, the transverse shear stress could be controlled so as to be within the ACI code allowable values.

Since the strut will not interfere with the operating of the fuel handling equipment and offers the least amount of rework to the existing structure, it was decided that the strut reinforcement was preferable to modifying the intersections to develop full fixity at the wall intersections in order to being the transverse shear within allowable values.

SRI/STARDYNE finite element computer program, which is traceable to the Control Data Corporation, was then used to model the whole fuel pool to analyze the hydrostatic effect on all other corners as well as to confirm the results of 3D/SAP. In this case, the plate bending elements were used for the static analysis.

The whole fuel pool was modeled as a three-dimensional structural system, with the floor slabs around the pools modeled as horizontal rigid beam elements. The thermal affect was calculated by hand and it was determined that the thermal stresses in the walls were not affected significantly by the hinged boundary conditions at the wall intersections.

Again, three cases were considered. The first was with full hydrostatic load in the spent fuel pool, tilt pit and cask pit without the strut. The second was with full hydrostatic load in the spent fuel pool with the strut across the tilt pit supporting the separation wall. The third run was without any hydrostatic load, but with a precompressed strut.

The first run confirmed a hand analysis of the transverse shear stress in the outer corners of the spent fuel pool, tilt pit and cask pit in which these stresses are within the allowable values given in the ACI code for a member without shear reinformcment. Consequently, no additional reinforcement is required in these areas.

The second run confirmed the results of 3D/SAP as regards the effect of the strut on the separation wall. The third run was used to determine the effect of the stiffness of the strut on the separation wall. From 3D/SAP it was determined that the stiffness of the strut would have to be large enough so as to keep the shear stresses in the separation wall below the allowable values given by the ACI code for members without shear reinforcement for the condition when the spent fuel pool is full and the tilt pit is empty. On the other hand, from the results of the third run of the STARDYNE program, it was determined that the strut should be so designed that it is strong enough to support the separation wall during the operation stage but not so stiff as to impose a significant thermal load into the separation wall causing excessive transverse shear for the case when the pool and tilt pit have the full hydrostatic load plus the maximum thermal load due to the accident case.

Since it is extremely difficult to satisfy these two adverse conditions, if not impossible, a compromise solution has been adopted. The stiffness of the strut was determined so as to provide a shear stress in the separation wall which would be within the allowable value given by the ACI code for members with shear reinforcement for the case of the spent fuel pool with hydrostatic load and the tilt pit empty. The required shear reinforcement will be provided in the existing separation wall by drilling holes through the wall and grouting in bolts.

Although the analysis indicates that a single strut is sufficient reinforcement an additional strut aligning with the west wall of the spent fuel pool is included in the reinforcement modifications since it is difficult if not impossible to predict the diagonal crack pattern in this area.