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UTLEY,E.E. Carolina Power & Light Co.
RECIP.NAME RECIPIENT AFFILIATION
VARGA,S.A. Operating Reactors Branch 1

SUBJECT: Forwards addl info re 801201 request for amend of License DPR-23 to expand spent fuel pool storage.Effects of increased loads on fuel pool liner & structures provided. Replacement pages to 801201 submittal attached.

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CP&L
Carolina Power & Light Company

June 18, 1981

File: NG-3514(R) Serial No.: NO-81-1055

Office of Nuclear Reactor Regulation
ATTENTION: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
United States Nuclear Regulatory Commission
Washington, D. C. 20555

H. B. ROBINSON STEAM ELECTRIC PLANT UNIT NO. 2
DOCKET NO. 50-261
LICENSE NO. DPR-23
REVISION TO REQUEST FOR LICENSE AMENDMENT
SPENT FUEL POOL STORAGE EXPANSION

Dear Mr. Varga:

On December 1, 1980, Carolina Power & Light Company (CP&L) submitted a request for license amendment to allow modification of the spent fuel pool for increased storage of spent fuel. We included a report identifying the proposed modifications and the safety analysis in support of our proposal. The report identified several areas where further analysis was ongoing which we would provide you at a later date. A portion of this information was provided by letter dated April 10, 1981. The purpose of this letter is to provide you with the balance of this information.

The following is a listing of the affected sections of the December 1, 1980 report:

a. Revised paragraphs for Section 4.4 to reflect completion of the final seismic analysis.

b. Revised paragraph for Section 6.0 to show the need for only one column to support the fuel pool floor.

c. Revised Figure 6-1 showing location of the single column.

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411 Fayetteville Street ∘ P. O. Box 1551 ∘ Raleigh, N. C. 27602

The attachment to this letter contains replacement pages to our December 1, 1980 submittal which are affected by this revision. The changes are highlighted by a vertical line in the right hand margin.

Please contact my staff if you have any questions concerning this revision.

Yours very truly,

E. E. Utley
Executive Vice President
Power Supply and
Engineering & Construction

SDF/jc (6580)
Attachments

cc: Mr. J. D. Neighbors

4.4 EFFECTS OF INCREASED LOADS ON THE FUEL POOL LINER AND STRUCTURES

The new spent fuel racks are free standing and are not connected to either the walls or floor of the pool as are the existing racks. Therefore, the effect of the new racks on the wall liner is less than that imposed by the existing racks. The sliding shear forces imparted to the floor liner under postulated earthquake conditions exceed those produced under the previous design; however, the sliding shear is well within the allowable working stresses of the liner material.

The final investigation shows that with the addition of one steel column under the fuel pool floor, as described in Section 6.0, the structure will have adequate capacity to carry the increased loads imposed by the new high density spent fuel storage racks. R2

The spent fuel pool structure has been evaluated for new loads based on the following criteria:

a) Building Code Requirements for Reinforced Concrete. The ACI 318-63 Code.

b) H. B. Robinson Unit No. 2 Final Safety Analysis Report.

c) USNRC Operating Technical Position for Review and Acceptance of Spent Fuel Storage and Handling Applications.

d) American Standards Association ASA A58.1-1955.

e) American Institute of Steel Construction (AISC) Specification for the Design, Fabrication and Erection of Structural Steel for Buildings, Sixth Edition, 1963. R2

f) Phillips Catalog F-1000, For Wedge Anchors.

Based on the above criteria the following is a listing of the primary loads considered in the structural evaluation.

a) The dead weight of the structural elements including crane column dead loads and the hydrostatic load from the pool water (D_1+D_2). R2

b) Live load including crane column live load (fuel cask) with impact and thrust (L_o)

c) Live load of existing fuel racks and fuel elements (L_1). R2

d) Equipment load (Cask) (L_2).

e) Equipment load (New Racks) (L_3). R2

f) Wind Load N-S (W-NS)

Wind Load S-N (W-SN)

Wind Load E-W (W-EW)

Wind Load W-E (W-WE)

g) Cask drop equivalent static load on slab (FC)

h) OBE N-S + VERT (EO-NS+EO-VERT) + OBE N-S (New Racks) ($EO-NS_1/WE_1;NS_2/EW_1$)

OBE S-N + VERT (EO-SN+EO-VERT) + OBE S-N (New Racks) ($EO-SN_1/WE_2;SN_2/EW_2$)

OBE E-W + VERT (EO-EW+EO-VERT) + OBE E-W (New Racks) ($EO-NW_2/EW_1;SN_2/EW_2$)

OBE W-E + VERT (EO-WE+EO-VERT) + OBE W-E (New Racks) ($EO-NS_1/WE_1;SN_1/WE_2$)

SSE N-S + VERT (ESS-NS+ESS-VERT) + SSE N-S (New Racks) ($ESS-NS_1/WE_1;NS_2/EW_1$)

SSE S-N + VERT (ESS-SN+ESS-VERT) + SSE S-N (New Racks) ($ESS-SN_1/WE_2;SN_2/EW_2$)

SSE E-W + VERT (ESS-EW+ESS-VERT) + SSE E-W (New Racks) ($ESS-NS_2/EW_1;SN_2/EW_2$)

SSE W-E + VERT (ESS-WE+ESS-VERT) + SSE W-E (New Racks) ($ESS-NS_1/WE_1;SN_1/WE_2$) R2

i) A thermal loading (T_o) due to a pool water temperature of 150°F resulting in a Δt = 80°F. The shrinkage of the concrete that has occurred since construction was calculated conservatively as an equivalent difference of 22°F thus reducing the effective Δt = 80°-22°=58°F.

Load combinations are in accordance with ACI-318-63 Part IV B.

The following load combinations are used to evaluate the concrete structural elements:

1) $1.5(D_1+D_2)+1.8(L_o+L_1+L_3)+1.0FC$ (L_o=0 During Cask Impact) Normal

2) $1.5(D_1+D_2)+1.8(L_o+L_1+L_3)$ Operating

3) $1.25(D_1+D_2+L_o+L_1+L_2+L_3)1.25WN-S$ (L_o=0 During Wind) Wind

4) $1.25(D_1+D_2+L_o+L_1+L_2+L_3)+1.25WS-N$ R2

5) $1.25(D_1+D_2+L_o+L_1+L_2+L_3)+1.25WE-W$

6) $1.25(D_1+D_2+L_o+L_1+L_2+L_3)+1.25WW-E$

7) $1.25(D_1+D_2+L_1+EO-NS+EONS_1/WE_1+EOVERT)+1.0FC$ OBE

8) $1.25(D_1+D_2+L_1+EO-NS+EONS_2/EW_1+EOVERT)+1.0FC$

9) $1.25(D_1+D_2+L_1+EO-SN+EOSN_1/WE_2+EOVERT)+1.0FC$

10) $1.25(D_1+D_2+L_1+EO-SN+EOSN_2/EW_2+EOVERT)+1.0FC$

11) $1.25(D_1+D_2+L_1+EOEW+EONS_2/EW_1+EOVERT)+1.0FC$

12) $1.25(D_1+D_2+L_1+EOEW+EOSN_2/FW_2+EOVERT)+1.0FC$

13) $1.25(D_1+D_2+L_1+EOWE+EONS_1/WE_1+EOVERT)+1.0FC$

14) $1.25(D_1+D_2+L_1+EOWE+EOSN_1/WE_2+EOVERT)+1.0FC$

15) $1.25(D_1+D_2+L_o+L_1+EONS+EONS_1/WE_1+EOVERT)$

16) $1.25(D_1+D_2+L_o+L_1+EONS+EONS_2/EW_1+EOVERT)$

17) $1.25(D_1+D_2+L_o+L_1+EOSN+EOSN_1/WE_2+EOVERT)$

18) $1.25(D_1+D_2+L_o+L_1+EOSN+EOSN_2/EW_2+EOVERT)$

19) $1.25(D_1+D_2+L_o+L_1+EOEW+EONS_2/EW_1+EOVERT)$

20) $1.25(D_1+D_2+L_o+L_1+EOEW+EOSN_2/EW_2+EOVERT)$

21) $1.25(D_1+D_2+L_o+L_1+EOWE+EOSN_1/WE_1+EOVERT)$

22) $1.25(D_1+D_2+L_o+L_1+EOWE+EOSN_1/WE_2+EOVERT)$

23) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}NS+ESSNS_1/WE_1+ESSVERT)+1.0FC$ SSE

24) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}NS+ESSNS_2/EW_1+ESSVERT)+1.0FC$ R2

25) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}SN+ESSSN_1/WE_2+ESSVERT)+1.0FC$

26) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}SN+ESSSN_2/EW_2+ESSVERT)+1.0FC$

27) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}EW+ESSNS_2/EW_1+ESSVERT)+1.0FC$

28) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}EW+ESSSN_2/EW_2+ESSVERT)+1.0FC$

29) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}WE+ESSNS_1/WE_1+ESSVERT)+1.0FC$

30) $1.05(D_1+D_2)+1.0L_1+1.0(ESS\text{-}WE+ESSSN_1/WE_2+ESSVERT)+1.0FC$

31) $1.05(D_1+D_2)+1.0L_o+1.0L_1+1.0(ESS\text{-}NS+ESSNS_1/WE_1+ESSVERT)$

32) $1.05(D_1+D_2)+1.0L_o+1.0L_1+1.0(ESS\text{-}NS+ESSNS_2/EW_1+ESSVERT)$

33) $1.05(D_1+D_2)+1.0L_o+1.0L_1+1.0(ESS\text{-}SN+ESSSN_1/WE_2+ESSVERT)$

34) $1.05(D_1+D_2)+1.0L_o+1.0L_1+1.0(ESS\text{-}SN+ESSSN_2/EW_2+ESSVERT)$

35) $1.05(D_1+D_2)+1.0(L_o+L_1)+1.0(ESSEW+ESSNS_2/EW_1+ESSVERT)$

36) $1.05(D_1+D_2)+1.0(L_o+L_1)+1.0(ESSEW+ESSNS_2/EW_2+ESSVERT)$

37) $1.05(D_1+D_2)+1.0(L_o+L_1)+1.0(ESSWE+ESSNS_1/WE_1+ESSVERT)$

38) $1.05(D_1+D_2)+1.0(L_o+L_1)+1.0(ESSWE+ESSSN_1/WE_2+ESSVERT)$

39) $1.4(D_1+D_2)+1.4T_o$

40) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}NS+EO\text{-}NS_1/WE_1+EO\text{-}VERT)1.04T_o)$

41) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}NS+EO\text{-}NS_2/EW_1+EO\text{-}VERT)1.04T_o)$

42) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}SN+EO\text{-}SN_1/WE_2+EO\text{-}VERT+1.4T_o)$

43) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}SN+EO\text{-}SN_2/EW_2+EO\text{-}VERT)1.4T_o)$

44) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}EW+EO\text{-}NS_2/EW_1+EO\text{-}VERT)1.4T_o)$

45) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}EW+EO\text{-}SN_2/EW_2+EO\text{-}VERT)1.4T_o)$

46) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}WE+EO\text{-}NS_1/WE_1+EO\text{-}VERT)1.4T_o)$

47) $0.75(1.4(D_1+D_2)+1.7(L_1+L_2)+1.9(EO\text{-}WE+EO\text{-}SN_1/WE_2+EO\text{-}VERT)1.4T_o)$

48) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0T_o)$

49) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0T_o)$

50) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)+1.0T_o)$

51) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_2/EW_2+ESS\text{-}VERT)+1.0T_o)$

52) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}EW+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0T_o)$ R2

53) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}EW+ESS\text{-}SN_2/EW_2+ESS\text{-}VERT)+1.0T_o)$

54) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}WE+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0T_o)$

55) $1.0(D_1+D_2)+1.0(L_1+L_2)+1.0(ESS\text{-}WE+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)+1.0T_o)$

Load combinations for the steel column are as follows:

At Normal AISC Working Stress

1) $U=1.0(D_2+L_o+L_3)+1.0FC$ (L_o=0 During Cask Impact)

2) $U=1.0(D_2+L_o+L_3)$

At Normal AISC Working Stress x 1.33

3) U=1.0(D2+Lo+L3)+1.0W-NS

4) U=1.0(D2+Lo+L3)+1.0W-SN

5) U=1.0(D2+Lo+L3)+1.0W-EW

6) U=1.0(D2+Lo+L3)+1.0W-WE

7) $U=1.0(D_2)+1.0(EO\text{-}NS\text{-}EO\text{-}NS_1/WE_1+EO\text{-}VERT)+1.0FC$

8) $U=1.0(D2)+1.0(EO\text{-}NS+EO\text{-}NS_2/EW_1+EO\text{-}VERT)+1.0FC$

9) $U=1.0(D_2)+1.0(EO\text{-}SN+EO\text{-}SN_1/WE_2+EO\text{-}VERT)+1.0FC$

10) $U=1.0(D_2)+1.0(EO\text{-}SN+EO\text{-}SN2/EW2+EO\text{-}VERT)+1.0FC$

11) $U=1.0(D_2)+1.0(EO\text{-}EW+EO\text{-}NS_2/EW_1+EO\text{-}VERT)+1.0FC$

12) $U=1.0(D_2)+1.0(EO\text{-}EW+EO\text{-}SN_2/EW_2+EO\text{-}VERT)+1.0FC$

13) $U=1.0(D_2)+1.0(EO\text{-}WE+EO\text{-}NS_1/WE_1+EO\text{-}VERT)+1.0FC$

14) $U=1.0(D_2)+1.0(EO\text{-}WE+EO\text{-}SN_1/WE_2+EO\text{-}VERT)+1.0FC$

15) $U=1.0(D_2+L_o)+1.0(EO\text{-}NS+EONS_1/WE_1+EO\text{-}VERT)$

16) $U=1.0(D_2+L_o)+1.0(EO\text{-}NS+EONS_2/WE_1+EO\text{-}VERT)$

17) $U=1.0(D_2+L_o)+1.0(EO\text{-}SN+EOSN_1/WE_2+EO\text{-}VERT)$

18) $U=1.0(D_2+L_o)+1.0(EO\text{-}SN+EOSN_2/EW_2+EO\text{-}VERT)$

19) $U=1.0(D_2+L_o)+1.0(EO\text{-}EW+EONS_2/EW_1+EO\text{-}VERT)$

20) $U=1.0(D_2+L_o)+1.0(EO\text{-}EW+EOSN_2/EW_2+EO\text{-}VERT)$

21) $U=1.0(D_2+L_o)+1.0(EO\text{-}WE+EONS_1/WE_1+EO\text{-}VERT)$

22) $U=1.0(D_2+L_o)+1.0(EO\text{-}WE+EOSN_1/WE_2+EO\text{-}VERT)$

<u>At Normal AISC Working Stress x 1.5</u> R2

23) $U=1.0(D_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0FC$

24) $U=1.0(D_2)+1.0(ESS\text{-}NS+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0FC$

25) $U=1.0(D_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)+1.0FC$

26) $U=1.0(D_2)+1.0(ESS\text{-}SN+ESS\text{-}SN_2/EW_2+ESS\text{-}VERT)+1.0FC$

27) $U=1.0(D_2)+1.0(ESS\text{-}EW+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)+1.0FC$

28) $U=1.0(D_2)+1.0(ESS\text{-}EW+ESS\text{-}SN_2/EW_2+ESS\text{-}VERT)+1.0FC$

29) $U=1.0(D_2)+1.0(ESS\text{-}WE+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)+1.0FC$

30) $U=1.0(D_2)+1.0(ESS\text{-}WE+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)+1.0FC$

31) $U=1.0(D_2+L_o)+1.0(ESS\text{-}NS+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)$

32) $U=1.0(D_2+L_o)+1.0(ESS\text{-}NS+ESS\text{-}NS_2/EW_1+ESS\text{-}VERT)$

33) $U=1.0(D_2+L_o)+1.0(ESS\text{-}SN+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)$

34) $U=1.0(D_2+L_o)+1.0(ESS\text{-}SN+ESS\text{-}SN_2/EW_2+ESS\text{-}VERT)$

35) $U=1.0(D_2+L_o)+1.0(ESS\text{-}EW+ESS\text{-}SN_2/EW_1+ESS\text{-}VERT)$

36) $U=1.0(D_2+L_o)+1.0(ESS\text{-}EW+ESS\text{-}NS_2/EW_2+ESS\text{-}VERT)$

37) $U=1.0(D_2+L_o)+1.0(ESS\text{-}WE+ESS\text{-}NS_1/WE_1+ESS\text{-}VERT)$ R2

38) $U=1.0(D_2+L_o)+1.0(ESS\text{-}WE+ESS\text{-}SN_1/WE_2+ESS\text{-}VERT)$

For the final investigation, three dimensional finite element computer models were developed for the Spent Fuel Pool Structure. Plate elements were utilized to simulate the reinforced concrete wall and slab structure; beam elements were used to simulate the column. The computer model assumed the boundary to be fixed between fuel pool walls and supporting mat. The column was assumed fixed to the mat as well. R2

The analysis was performed using the MRI/STARDYNE (3) Structural Analysis System (which is in the public domain). The static analysis package of MRI/STARDYNE - "STAR" was utilized to evaluate the internal forces and displacements induced in the spent fuel pool structure due to the primary loadings. Load combinations and force envelopes were developed using "STAR" output data exclusive of thermal loads. Internal forces due to thermally induced loads were added to maximum mechanical internal forces using elastic strain compatability analysis methods. A thorough review of the envelope of maximum moments, axial forces, and shears in the critical structural elements indicates that the fuel pool structure is adequate to support the new rack loads under all possible loading combinations. R2

6.0 INSTALLATION

The H. B. Robinson Unit No. 2 spent fuel pit is now in use for storage of spent fuel. Removal of a portion of the existing fuel storage racks and installation of the replacement High Density Fuel Storage System (HDFSS) modules will be accomplished without emptying the pool. Fuel shuffling will be required to permit the changeout of the storage racks.

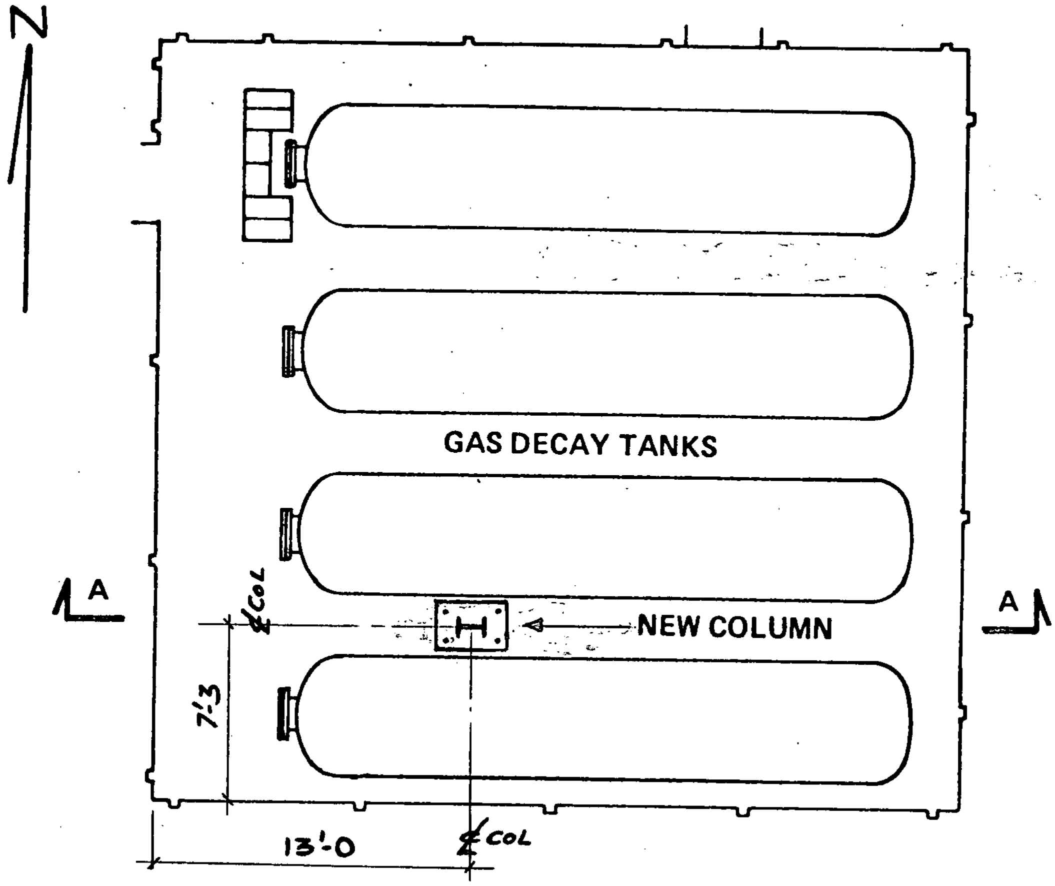
It will be necessary to provide additional support for the fuel pool floor. This will be accomplished by provision of one structural steel column in the gas decay tank storage room which is below the fuel pool. Column configuration is indicated in Figure 6-1. The column will transmit its load to the existing building slab and will be installed utilizing drilled-in anchor bolts and non-shrink grouting beneath the column base plate. Stressing the column is expected to be accomplished by lowering the water level in the pool approximately seven (7) feet during installation. After installing the column, the pool will be returned to normal water level to accomplish the required post stress. This work will be done prior to any increase in the load. R2

The existing overhead cask crane will be used to transport the racks into the fuel handling building. The existing fuel handling bridge crane will not be used to handle the rack components during the changeout. A temporary traveling bridge and hoist will be provided on the fuel handling bridge rails of sufficient capacity and headroom to remove the existing racks and to install the new HDFSS modules. The temporary traveling bridge will be designed such that it will not interfere with usage of the existing fuel handling bridge crane. Measures will be taken to eliminate the possiblility of interference or collision between the cranes. The hoisting sequence will be planned to prevent transporting loads over stored spent fuel during the modification.

The HDFSS modules are designed to be free-standing with a bottom-supported design. They rest on integral leveling pads on the floor of the fuel storage pool. Three 8-cell by 12-cell modules and one 8-cell by 10-cell module will be installed. The modules are designed such that the edges facing the pool walls will not contain any poison (Figure 2-6). Prior to installation,the racks will need to be checked for proper orientation to ensure that the periphery edges are non-poisoned.

Space will be provided for the 8-cell by 10-cell free-standing module by removal of a single originally installed 4-cell by 4-cell rack east of the cask area. Space for the three 8-cell by 12-cell free-standing modules will be provided by removing three 4-cell by 4-cell originally installed racks and four 3-cell by 3-cell mechanically restrained racks which were installed in 1976 after the pool was in service. The support feet on the original racks are welded to pads on the floor of the pool, and the racks installed in 1976 are mechanically restrained from the pool walls and wedged between original racks.

It will be necessary to shuffle spent fuel to ensure that the maximum possible distance between divers, required during the installation sequence, and stored spent fuel will be maintained during the removal of existing racks. In order to accomplish this, the rack occupying the area for the 8-cell by 10-cell



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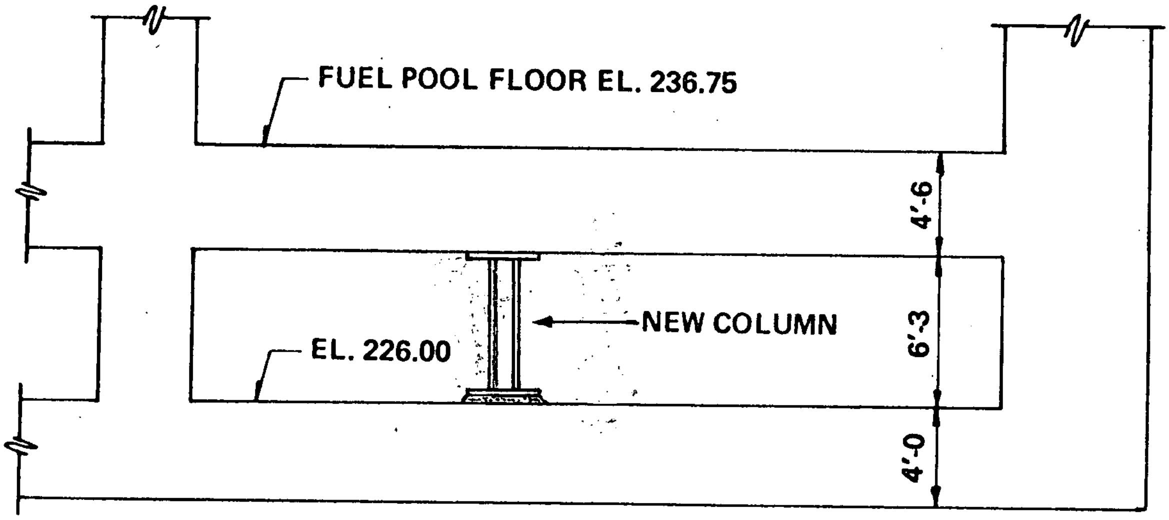

SECTION A-A

R2

R2

R2

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2 Carolina Power & Light Company SPENT FUEL POOL STORAGE EXPANSION	FUEL POOL STRUCTURAL MODIFICATIONS	FIGURE 6-1