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SUBJECT: Forwards util revised response to questions re spent fuel pool rerack design analysis. Addl confidence that racks will not impact walls, behavior of two dimensional multiple rack model under seismic condition will be evaluated.

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FPL

DECEMBER 23 1987

L-87-535

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Re: St. Lucie Unit 1
Docket No. 50-335
Spent Fuel Pool Rerack - Design and Analysis

By letter L-87-245, dated June 12, 1987, Florida Power & Light Company (FPL) submitted a proposed license amendment to permit replacement of the spent fuel pool racks at St. Lucie Unit 1 to ensure that sufficient future capacity exists for storage of spent fuel.

By letter dated August 20, 1987 (E. G. Tourigny to C. O. Woody) the NRC Staff requested additional information in the area of the spent fuel pool rack description, design and analysis it needed to continue its review of this proposed license amendment. By letter L-87-422 dated October 20, 1987, FPL submitted a response to this request. As a result of subsequent discussions with the NRC, it was determined that FPL's response to several questions would need to be revised. Attached are FPL's revised responses.

If additional information is required, please contact us.

Very truly yours,

C. O. Woody
Executive Vice President

COW/EJW/gp.

Attachment

cc: Dr. J. Nelson Grace, Regional Administrator, Region II, USNRC
Senior Resident Inspector, USNRC, St. Lucie Plant

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1/1

Question 2d - Have impacts between fuel racks and the pool walls been considered? Do the walls have sufficient margin to accommodate these loads?

Response 2d - The potential for rack-to-wall impact has been considered in the fuel rack models. Impact springs are included in the model at both the base plate level and at the girdle bar level on all four sides of the rack being modelled to account for this potential. The true rack-to-wall spacing (less the projection of the girdle bar or base plate, as applicable) is input as a clear gap between the rack structure and the spring.

Table 3 presents the calculated displacements for racks G1, B2 and H1 for assumed friction coefficients of 0.2 and 0.8. The maximum calculated rack displacement under the analyzed design conditions is 1.82 inches, which is less than the actual rack-to-wall spacing (minimum 4 inches). Therefore, analysis of the pool walls for impact loading was not required.

To obtain additional confidence that the racks will not impact the walls, the behavior of a two-dimensional multiple rack model under the seismic condition will be evaluated. See response to Question 3g for additional discussion.

TABLE 3

RACK DISPLACEMENT SUMMARY

RACK	REMARKS	MAX. DISP. SHORT DIRECTION (IN)	MAX. DISP. LONG DIRECTION (IN)	MAX. VERT. DISPL. (IN)
G1	μ = .2, full	.3884	.6305	0.
G1	μ = .8, full	1.8197	.6110	$.97377 \times 10^{-1}$
G1	μ = .8, convergence	1.7407	.6147	$.90944 \times 10^{-1}$
G1	μ = .2, 1/2 full	.3566	.4071	$.12229 \times 10^{-1}$
G1	μ = .8, 1/2 full	.8427	.3744	$.85291 \times 10^{-1}$
B2	μ = .2, "empty"	.1517	.0898	0.
B2	μ = .8, "empty"	.1120	.2287	$.43159 \times 10^{-1}$
B2	μ = .2, full	.2464	.2088	0.
B2	μ = .8, full	.5317	.4238	$.29708 \times 10^{-1}$
B2	μ = .8, 1/2 full	.3802	.2786	$.31333 \times 10^{-1}$
H1	μ = .8, full	.5092	.2548	$.31422 \times 10^{-1}$
H1	μ = .2, 1/2 full	.2107	.2132	$.69853 \times 10^{-2}$
H1	μ = .8, 1/2 full	.2731	.2241	$.44346 \times 10^{-1}$

Question 3f - Were rack modules B2, G1, and H1 the only racks analyzed as indicated in Table 4-10? On what basis were these racks selected?

Response 3f - Modules B2, G1, H1 are the racks analyzed to show that structural integrity is maintained during a seismic event. These racks were chosen on the following bases:

B2 - representative of region 1 configuration (the largest region 1 rack); this rack is adjacent to two walls.

G1 - a large region 2 rack near the cask area; this rack has 6 feet, 2 of which (nearest the cask area) have an initial gap and are designed to come into contact with the floor only when rocking is sufficient to close the gap. The eccentric placement of its main support legs causes this rack to be relatively more prone to rocking, thus resulting in potentially higher stresses than a more conventional region 2 rack. The relatively unique configuration of this rack thus makes it a logical candidate for analysis.

H1 - This is a region 2 rack with a cut-out and one additional support foot. For conservatism, the rack was considered to have 104 cells loaded with fuel, but used a planform for analysis that was less stable than the planform actually present. The uniqueness of this rack required that it be analyzed.

Table 4 presents a summary of critical loads and stresses in the rack structure as obtained from the analyses. The location numbers given in the table correspond to those shown in Figures JPE-LR-87-043-1 and JPE-LR-87-043-2.

Table 5 presents a summary of maximum (maximum in time and in space) values of the stress factors R1 through R6 at critical locations in the rack module. These terms are defined in Subsection 4.6.2.4 of the St Lucie Plant Unit No 1 Spent Fuel Storage Facility Modification, Safety Analysis Report, transmitted via letter L-87-245 dated June 12, 1987.

TABLE 4

SUMMARY OF CRITICAL LOADS AND STRESSES

Location	Item	Safety Factor	Maximum Value
1.	Normal load on liner per support foot	-	279673 # (Region 1) 223083 # (Region 2)
2.	Shear load acting at base of support foot	-	186325 # (Region 1) 165014 # (Region 2)
3.	Support foot to baseplate weld stress due to maximum shear and normal forces on a single foot	Calculated factor of safety of welds at this location is 2.44. The weld configuration is an interior groove weld, an exterior groove weld, and an exterior fillet weld.	
4.	Shear load transmitted by baseplate near a support foot	3.0	279673 # (calculated) 839506 # (allowable, based on ultimate strength of baseplate in shear)
5.	Compressive stress in cell wall at lower corner due to direct and bending loads on rack	4.56	5247 psi (calculated) 23902 psi (based on stability)
6.	Stress in cell wall above active fuel area due to impact loads on girdle bar	2.54	9105 psi (calculated) 23150 psi (allowable)
7.	Girdle bar shear stress	1.70	7837 psi (calculated) 13358 psi (allowable)
8.	Total impact load on girdle bar due to inter-rack contact (one side)	2.17	4.974×10^5 # (calculated) 1.078×10^6 # (capacity)

TABLE 4
(continued)

Summary of Critical Loads and Stresses

Location	Item	Safety Factor	Maximum Value
9.	Cell to gap channel weld stress due to direct and bending loads on rack	2.94	9289 psi (calculated) 27300 psi (allowable)
10.	Cell to gap channel weld stress due to effects of an isolated hot cell	2.20	12424 psi (calculated) 27300 psi (allowable)
11.	Cell to baseplate weld stress due to direct and bending loads on rack	3.15	8653 psi (calculated) 27300 psi (allowable)
—	Instantaneous impact load between fuel assemblies and cell wall	3.58	2245 # (calculated-per cell) 8032 # (allowable per cell, based on limit load calculation)
—	Rack/wall impact loads		No impacts with pool walls occur at any locations

It should be noted that the calculated values have been obtained for racks subjected to:

1. SSE seismic event
2. Fuel load weight of 2500#/cell

TABLE 5

STRESS FACTORS

Run No.	Stress Factors (Upper values for rack base - lower values for upper part of the support feet)					
	R_1	R_2	R_3	R_4	R_5	R_6
SSE μ = .8, full Module B2	.110 / .341	.078 / .351	.353 / .872	.341 / .631	.505 / 1.076	.576 / 1.210
SSE μ = .2, full Module B2	.089 / .211	.025 / .063	.176 / .117	.186 / .159	.290 / .311	.328 / .321
SSE μ = .8 Module B2 10 cells loaded	.017 / .092	.025 / .073	.077 / .155	.059 / .076	.107 / .194	.124 / .217
SSE μ = .8 Module H1 full	.119 / .346	.087 / .327	.320 / .776	.340 / .516	.572 / .905	.655 / 1.015
SSE μ = .8 Module H1 1/2 full in positive x-half	.068 / .218	.055 / .199	.211 / .439	.222 / .405	.335 / .582	.381 / .653
SSE μ = .2 Module H1 1/2 full in positive x-half	.050 / .164	.014 / .046	.087 / .076	.180 / .092	.245 / .244	.280 / .258

TABLE 5
(continued)

STRESS FACTORS

Run No.	R_1	R_2	R_3	R_4	R_5	R_6
	Stress Factors (Upper values for rack base - lower values for upper part of the support feet)					
SSE μ = .2 Module B2 10 cells loaded	.014 / .046	.005 / .013	.038 / .025	.048 / .035	.061 / .063	.020 / .066
SSE μ = .8, 1/2 full Pos. X Quadrant Module B2	.058 / .220	.052 / .242	.271 / .492	.200 / .247	.300 / .666	.345 / .740
SSE μ = .8, Full (smaller ΔT) Module G1	.130 / .427	.100 / .426	.391 / .917	.264 / .549	.506 / 1.136	.576 / 1.273
SSE μ = .8, Full Module G1	.133 / .421	.100 / .427	.392 / .918	.267 / .577	.495 / 1.137	.562 / 1.27
SSE μ = .2 Module G1 Full	.094 / .297	.027 / .085	.219 / .175	.174 / .224	.331 / .436	.377 / .467
SSE μ = .8 Module G1 Positive x half loaded	.088 / .256	.061 / .229	.259 / .460	.221 / .599	.369 / .702	.425 / .792
SSE μ = .2, Module G1 Positive x half loaded	.052 / .169	.014 / .047	.120 / .098	.190 / .128	.262 / .254	.300 / .269

Question 3m - Provide justification for modeling the fuel assemblies as independent rattling masses.

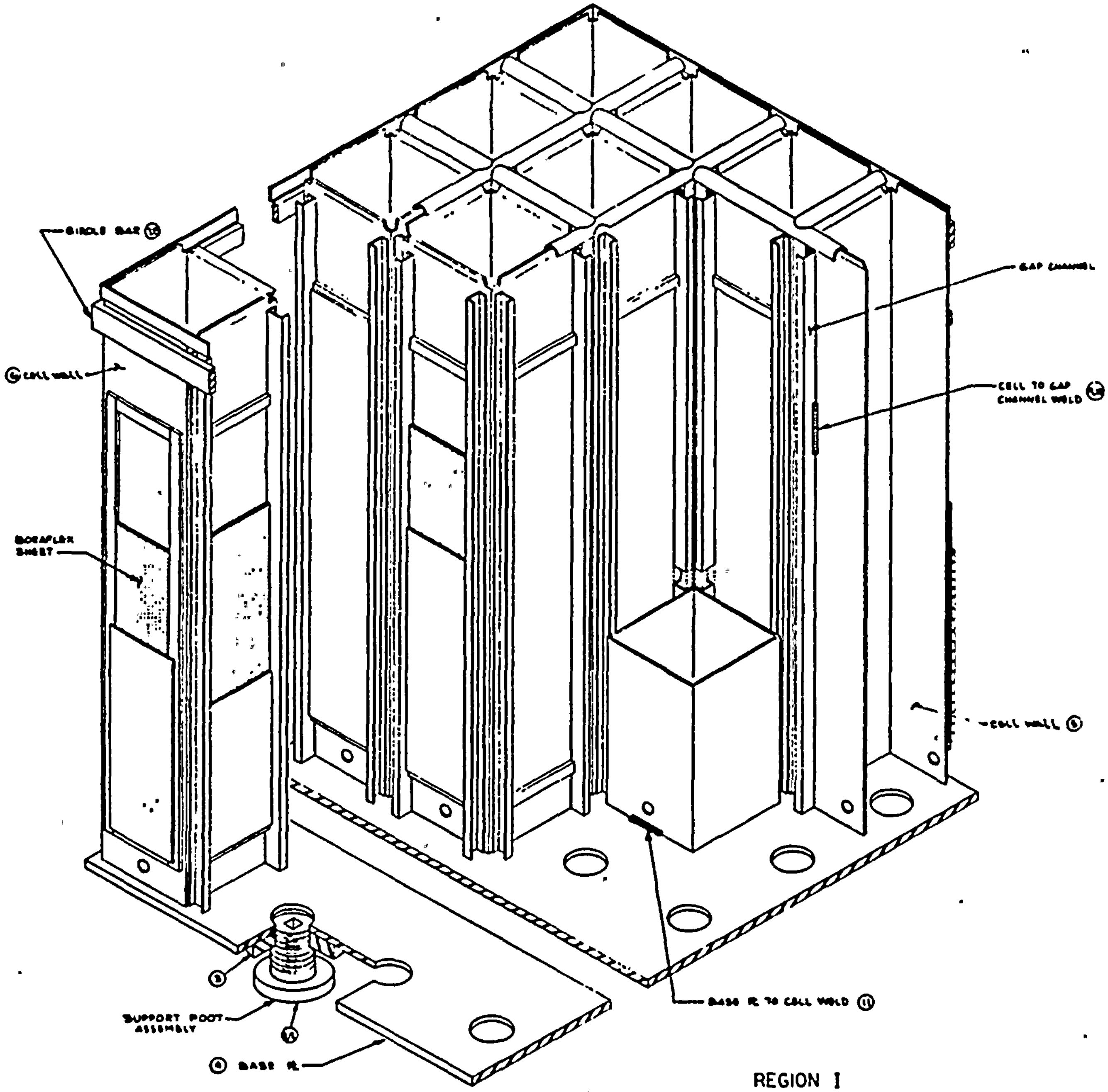
Response 3m - Additional analyses have been performed for the G1 rack assuming a fuel assembly weight per cell of 1300 lbs and a coefficient of friction of 0.8. Two runs were made: one considering the fuel assembly as a series of independent rattling masses, and one considering the fuel assembly as a series of masses connected by elastic members to simulate a beam-type structure. The effective spring rates for these elastic members were approximated from the fuel assembly behavior.

Table 6 presents the results of these two analyses, and a comparison with the design basis analysis for the G1 rack which assumed a fuel assembly weight of 2500 lbs per cell and independently rattling fuel masses. The table indicates that the assumption of fuel assembly elasticity has a small effect on the results and that both cases are enveloped by the design basis analysis.

TABLE 6

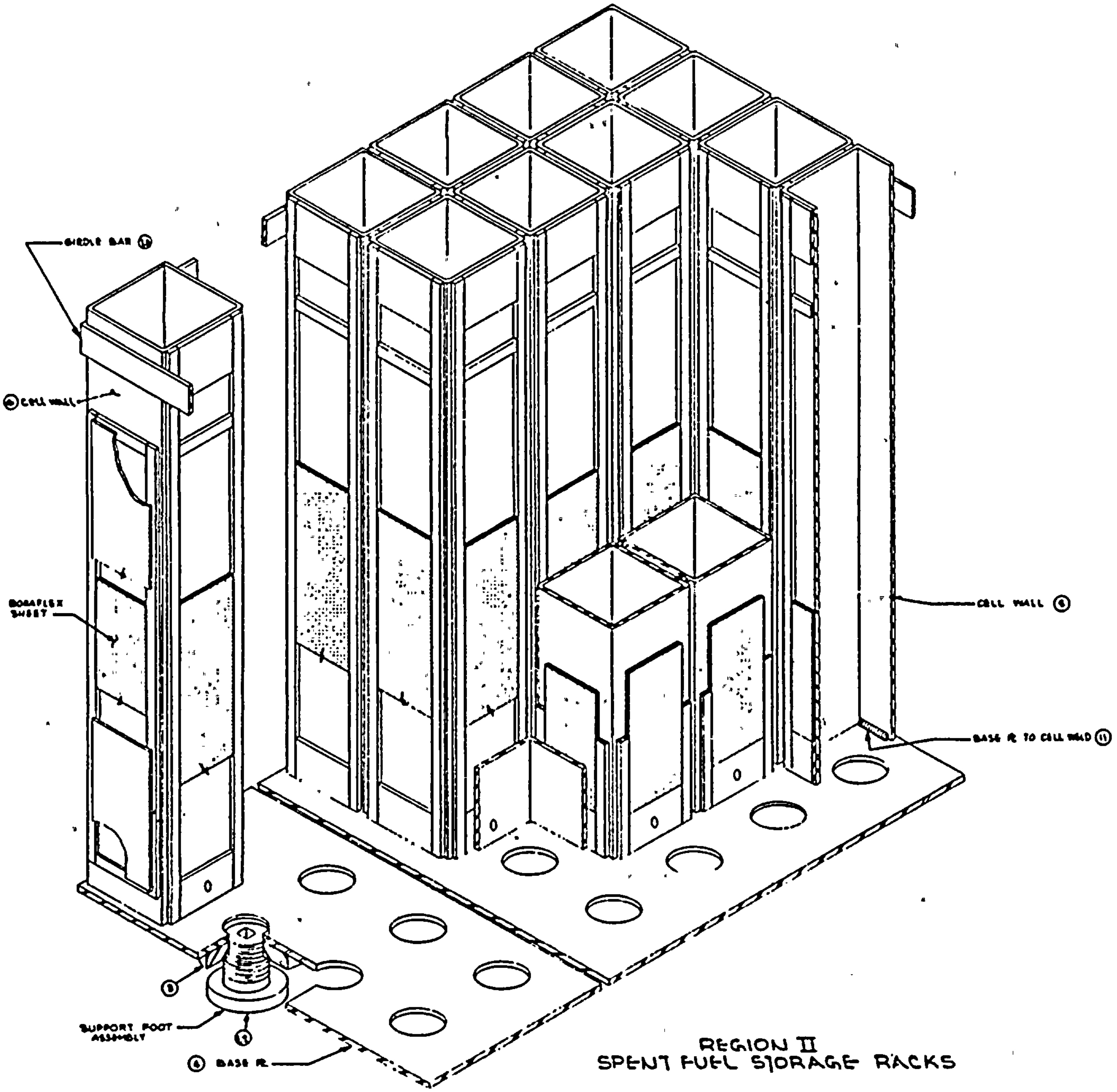
SUMMARY OF RESULTS - ST LUCIE G1 RACK WITH REGULAR FUEL (1300#), COF = .8

ITEM	INDEPENDENT FUEL MASSES	ELASTICALLY COUPLED FUEL MASSES	SSE (2500# FUEL)
Fuel/Rack Impact (#/cell)	453.3	514.4	1221.3
Rack/Rack Impact (#)			
Baseplate	7.133×10^4	6.249×10^4	1.359×10^5
Girdle Bar	0.	0.	0.
Rack/Wall Impact (#)			
Baseplate	0.	0.	0.
Girdle Bar	0.	0.	0.
R6 Stress Factors			
Rack Base	.401	.421	.576
Support	.736	.795	1.273
Max. Displacement (Short direction)(in)	.5717	.5709	1.7407
Max. Displacement (Long direction)(in)	.3230	.3479	.6147
Max. Displacement (vertical)(in)	.0823	.0802	.0909
Max. Floor Load (4 Feet) #	3.934×10^5	3.800×10^5	5.877×10^5
Max. Floor Load #			
Vertical	180237.	190218	279673
Shear	108454.	110134	186242.



REGION I
SPENT FUEL STORAGE RACKS

FLORIDA POWER & LIGHT COMPANY ST. LUCIE PLANT UNIT 1
REGION I FUEL RACK DESIGN FIGURE JPE-LR-87-043-1 REV 1



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 1

REGION II FUEL RACK DESIGN

FIGURE JPE-LR-87-043-2 REV 1