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DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Forwards addl info re seismic analysis of spent fuel racks proposed for use in spent fuel pool shared by units.Info provides simplified calculation of sliding of Westinghouse free-standing racks.

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November 25, 1980

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. R. W. Reid, Chief
Operating Reactors Branch No. 4

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270

Dear Sir:

Please find attached additional information concerning the seismic analysis of the spent fuel racks proposed for use in the spent fuel pool shared by Oconee Units 1 and 2. The attached information provides a simplified calculation of the sliding of the Westinghouse free-standing racks. This calculation, which by its simplification is more conservative than the non-linear analysis, shows a maximum sliding of 0.33 inches for the design seismic event. This result is within 10% of the result obtained by non-linear analysis. Furthermore, a factor of safety for impact of the rack with the wall was determined by the attached calculation to be 3.15.

Duke Power Company considers that the attached information supports the conclusions of the previously submitted non-linear analysis. Both analyses show that although sliding of the racks would occur for the assumptions of a design seismic event and conservative coefficient of friction, the sliding would be minimal and impact with the spent fuel pool wall would not occur.

Very truly yours,

William O. Parker, Jr.

FTP:scs
Attachment

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ADDITIONAL INFORMATION FOR NRC REVIEW OF THE

PROPOSED OCONEE SPENT FUEL RERACK CONCERNING THE SEISMIC ANALYSIS

SIMPLIFIED CALCULATION OF SLIDING OF THE WESTINGHOUSE FREE-STANDING RACKS FOR OCONEE UNITS 1 & 2

Description/Basis of Calculation:

The maximum sliding distance of the Westinghouse free-standing fuel rack for Oconee can be obtained by equating the strain energy developed in the fuel rack, in response to the SSE seismic event, to the energy dissipated by friction, during sliding between the fuel rack supports and the pool floor. The maximum strain energy in the fuel rack, produced by the SSE seismic event, can be calculated from given values used in the linear analysis referenced in the original licensing submittal.

Given Information:

Generalized Stiffness:

8x12 Fuel Rack Module — $K_G = 414{,}000$ lb/in

First Mode Frequency: — f_1 Horizontal = 4.6 Hz

Dominant Mode: — f_1 Vertical > 33 Hz

Fuel Rack Dead Weight:

8x12 Module — $W = 169{,}200$ lbs

Distance from Rack to Wall: — $D = 3.3$ in

Maximum Acceleration from Response Spectra of Pool: — Horizontal @ 4.6 Hz, $a_H = 174$ in/sec^2

Vertical @ 33 Hz, $a_V = 0.2$ g's

Coefficient of Friction Minimum Value: — $\mu = 0.2$

Maximum Energy Produced by the SSE Seismic Event:

Maximum Displacement: $X_{max} = a_H/\omega^2 = a_H/(2\pi f_1)^2$

$= 174/(2\pi 4.6)^2 = 0.208$ in

Maximum Strain Energy: $U_{max} = 1/2\ K_G\ X^2_{max}$

$= 1/2 \times 414{,}000 \times (0.208)^2 = 8960$ in-lbs

Frictional Energy Dissipated During Sliding:

Minimum Normal Force: $F_N = (1-a_V)W$

$= (1-0.2)\ 169{,}200 = 135{,}400$ lbs

Frictional Energy Dissipation During Sliding: $E_s = \mu\ F_N\ d$

$= 0.2 \times 135{,}400\ d = 27{,}080\ d$ in-lbs

Maximum Sliding Distance Caused by SSE Seismic Event:

Maximum Strain Energy = Frictional Energy

$U_{max} = E_s$

Maximum Sliding Distance: $d = \frac{U_{max}}{\mu F_N}$

$= \frac{8960}{27080} = 0.331$ in

Factor of Safety:

A factor of safety is defined as the ratio of the maximum acceleration level (necessary to cause impact between the rack and the wall) to the design acceleration level (based on the SSE seismic event).

Frictional Energy Dissipated During Sliding to Wall:

$$E_s = \mu F_N D$$

$$= 0.2 \times 135{,}400 \times 3.3 = 89{,}360 \text{ in-lbs}$$

Energy Produced by Seismic Event Necessary to Cause Impact:

Strain Energy = Frictional Energy

$$1/2\ K_G\ X_{max}^2 = E_s$$

$$X_{max} = \sqrt{2E_s/K_G}$$

$$= \sqrt{\frac{2 \times 89360}{414{,}000}} = 0.657 \text{ in}$$

Maximum Acceleration Level Necessary to Cause Impact:

$$A_{max} = X_{max}\ (2\pi f_1)^2$$

$$= 0.657\ (2 \times \pi \times 4.6)^2 = 549 \text{ in/sec}^2$$

Ratio of Maximum Acceleration Level to Design Acceleration Level:

Factor of Safety: $R = A_{max}/a_H$

$$= 549/174 = 3.15$$

Conclusion:

Based on the above calculations the maximum sliding distance caused by the SSE seismic event is 0.331 inches. The distance between the rack and the wall is 3.3 inches. A seismic event with the maximum acceleration level of 549 in/sec^2 is required before the rack could slide 3.3 inches and impact could occur. The factor of safety or ratio of maximum acceleration level to design acceleration level was calculated. This calculation shows that the Westinghouse free-standing racks are designed with a factor of safety of 3.15.