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O. W. DIXON, JR.
VICE PRESIDENT
NUCLEAR OPERATIONS

July 31, 1984

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

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
Spent Fuel Pool Rerack Modification
Structural Concerns

Dear Mr. Denton:

On January 28, 1984, South Carolina Electric and Gas Company (SCE&G) submitted a proposal to rerack the existing spent fuel pool at the Virgil C. Summer Nuclear Station. A meeting was held on July 25, 1984 between SCE&G and several members of the Nuclear Regulatory Commission Staff to address Staff concerns. As a result of this meeting, SCE&G was asked to supply the following additional analysis and clarifications.

The first question requested further clarification on the dropped fuel accident (Dropped Fuel Accident II) referenced on page 6-25 of the January 28, 1984 submittal. One fuel assembly is dropped from an elevation of 36 inches above the rack and hits the top of the storage location with a velocity of 114 inches per second. This impact produces a longitudinal stress wave of amplitude 16,412 pounds per square inch. An energy balance between the kinetic energy of the dropped assembly and the plastic strain energy of the rack panel shows that 2.11 inches of the top of the panel will be plastically deformed. The active fuel is located approximately 21 inches below the top of the rack. Therefore, over 18 inches of undeformed panel separates the dented zone from the active fuel zone. This indicates that the subcriticality of the stored fuel will not be compromised.

The second question requested further justification and clarification on the hydrodynamic coupling mass assumption used in the structural analysis. The fuel assembly is modelled as a blunt square body inside a square cross section container. The hydrodynamic coupling mass utilizes Fritz's well known correlations for infinitesimal motions. Inclusion of finite amplitude motions (which is the case for a rattling fuel assembly) is known to significantly reduce the peak rack seismic

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response (reference, "Dynamic Coupling in a Closely Spaced Two Body System Vibrating in a Liquid Medium," by A. I. Soler and K. P. Singh, Proc. of the Third International Conference on Vibration in Nuclear Plant, Keswick, U. K. 1982). Therefore, Fritz's equations used in the analysis lead to an upper bound on the solution.

The third question requested that further plant specific analysis be performed to demonstrate the convergence of the structural analysis. Rack A (11 x 11 Region 1 module) was run on the fourteen degree-of-freedom (DOF) model of the rack (coefficient of friction $\mu = 0.8$, all locations occupied). The results, tabulated in Attachment 1 for three discrete time steps, show convergence. The 32 DOF solution presented in the Janaury 28, 1984 submittal shows the maximum x and y displacements to be 0.78 inches and 0.86 inches, respectively. Therefore, it can be noted that the 32 DOF solution and 14 DOF solution are in close agreement.

The equations of motion in both models follow identical procedures, namely (i) write the contributory terms of kinetic energy for the rack, fuel assemblies, and fluid coupling effects, (ii) use Lagrange's equation of motion to obtain dynamic equations of equilibrium, (iii) establish the coupling ratios of all beam, stop and friction springs, (iv) promultiply the matrix equation by the inverted mass matrix to diagonalize the mass matrix, and (v) solve the resulting equation set using the central difference scheme.

The chief distinguishing feature between the two models is the absence of rotary inertia degree-of-freedom equations in the 14 DOF. The 32 DOF model has rotary inertia equations which forces the use of very small time steps. This complicating attribute of rotary inertia is well documented in the literature, for example

"...In many cases, the rotational inertia contributes very little to the total kinetic energy. In addition, it complicates a subsequent dynamic analysis by adding rotational degree-of-freedom to the problem and by adding high frequency terms to the response computation. The latter are particularly undesirable if the subsequent dynamic analysis is done using the step-by-step central difference approximations, since the time steps used then become very small..." (reference, "Component Element Method in Dynamics," Levy and Wilkinson, McGraw Hill, 1976, page 169.)

The similarities and differences between the 32 DOF and 14 DOF solutions are further summarized in Attachment 2.

As discussed in the July 25, 1984 meeting, SCE&G is currently scheduled to begin the first refueling outage for the Virgil C. Summer Nuclear Station in September 1984 coincident with core depletion. To prepare for this upcoming outage, SCE&G has arranged to begin receipt of the new spent fuel pool storage racks in the first week of August 1984. After this initial shipment, the remaining racks are scheduled to arrive at weekly intervals through mid-September. This schedule allows for full installation of all the racks at the time refueling operations commence.

As stated in previous submittals on this issue, an expeditious Staff resolution to these final concerns is required to support SCE&G's proposed reracking modification schedule. Also as discussed previously, performing this modification before first refueling is extremely important because of the safety and economic benefits derivable at the present time. Because the spent fuel pool is empty at present, radiation doses are ALARA now and will increase significantly after first refueling. Additionally, commitments have been formalized with the State of South Carolina requiring SCE&G to make all reasonable efforts to provide lifetime onsite storage of our spent fuel. Therefore we still consider it to be in the best interest of the general public and SCE&G to rerack the spent fuel pool before first refueling.

It is our understanding that the questions and responses contained herein resolve the final Staff concerns on this issue. Your expeditious review and cooperation with our schedule on this item is appreciated.

Very truly yours,

O. W. Dixon, Jr.

AMM/OWD/gj

cc: V. C. Summer
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ATTACHMENT I

14 DOF RESULTS

Time Step (seconds)	Maximum X-Displacement (inches)	Maximum Y-Displacement (inches)
.0003	0.829	0.853
.0002	0.830	0.854
.0001	0.829	0.854

ATTACHMENT 2

COMPARISON AND CONTRAST BETWEEN 32 DOF AND 14 DOF MODELS

	Item	32 DOF	14 DOF
(i)	Uses computer code DYNAHIS	Yes	Yes
(ii)	Integration scheme is central difference	Yes	Yes
(iii)	Hydrodynamic coupling mass is computed usir j Fritz's equations	Yes	Yes
(iv)	The analysis permits three dimensional motion of the structure	Yes	Yes
(v)	The rack proper is modelled by	24 degrees-of-freedom (pg. 6-5 of Licensing Report)	12 degrees-of-freedom (see reference 1)
(vi)	The vibrating fuel assembly group is permitted to have arbitrary x & y coordinates.	Yes	Yes
(vii)	The fuel assembly group has	8 degrees-of freedom	2 degrees-of-freedom
(viii)	The rack proper is modelled as	a lumped mass idealization	using a consistent mass matrix (see Reference 1)
(ix)	Structural Damping	approximately 2.5% of the critical mass	approximately 2.5% of the critical mass
(x)	Credit for "form drag"	No	No
(xi)	Credit for phase lag between various rattling assembly groups	No	No
(xii)	Credit for additional damping in the fuel assembly	No	No

(1) "Seismic Response of Free Standing Fuel Rack Construction to 3-D Floor Motion," A.I. Soler and K. P. Singh, Nuclear Engineering and Design, (c. 1984).