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PACIFIC GAS AND ELECTRIC COMPANY

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JAMES D. SHIFFER
VICE PRESIDENT
NUCLEAR POWER GENERATION

February 6, 1987

PGandE Letter No.: DCL-87-022

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

Re: Docket No. 50-275, OL-DPR-80
Docket No. 50-323, OL-DPR-82
Diablo Canyon Units 1 and 2
Spent Fuel Pool Reracking

Gentlemen:

As requested by NRC Staff letter dated January 22, 1987, enclosed is a description of additional parametric studies performed by PGandE related to rack-to-rack interactions for the Diablo Canyon high density spent fuel racks. These studies were performed in preparation for the Diablo Canyon reracking hearing scheduled for March 9, 1987.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Sincerely,

for J. D. Shiffer

Enclosure

cc: L. J. Chandler
J. B. Martin
M. M. Mendonca
P. P. Narbut
B. Norton
H. E. Schierling
CPUC
Diablo Distribution
Reracking Service List

1280S/0048K/DWO/1998

NUCLEAR REGULATORY COMMISSION

Docket No. 50-275-OLA Official Exh. No. PG+E #5

In the matter of PG+E Company

Staff ______ IDENTIFIED ✓

Applicant ✓ RECEIVED ✓

Intervenor ______ REJECTED ______

Cont'g Off'r ______

Contractor ______ DATE 6-17-87

Other ______ Witness ______

Reporter Harry Stunne

ENCLOSURE

RACK INTERACTION STUDIES

1. INTRODUCTION

In preparation for the Atomic Safety and Licensing Board reracking hearing scheduled for March 9, 1987, PGandE performed additional rack interaction parametric studies. In particular, the studies were performed to confirm the adequacy of the analysis methodology for obtaining rack impact loads described in the Reracking Report (PGandE Letter No. DCL-85-333, dated September 19, 1985). As such, these studies, using simplified models, were focused on addressing specific issues raised by Dr. Ferguson regarding postulated rack behavior, rather than to determine the actual response of the racks. The complex rack response was previously determined using a much more detailed model than those discussed in this enclosure. The detailed model was described in the Reracking Report and was previously reviewed and approved by the NRC. A brief description of the simplified analytical models developed for the parametric studies mentioned above and the results of these studies are provided below.

2. DESCRIPTION OF MODELS

Two simplified mathematical models of the racks were developed to perform the parametric studies: a single-rack model and a multi-rack model. For both models, fluid coupling effects were included in the analysis in a manner similar to that described in the Reracking Report.

A. Single-Rack Model

The single-rack model was developed for a 10 by 11 rack module fully loaded with fuel. The rack was simulated by two lumped masses (Figure 1). One-half the mass of the fuel assemblies was modeled as one lumped mass (Mass A) to simulate the rattling effect of the fuel assemblies. The other half was combined with the mass of the rack and was represented by the second lumped mass (Mass B), which was free to slide on a friction interface with a coefficient of friction equal to 0.2.

The methodology described in the Reracking Report included the following three conservative assumptions for rack analysis to account for postulated multiple-rack impacts.

- Each adjacent rack module was assumed to move in a manner equal and opposite (out of phase) to the rack module being analyzed. This assumption was incorporated in the model by utilizing a reference plane midway between adjacent racks.

- The fluid coupling coefficients were based on the conservative assumption that adjacent rows of racks are an infinite distance away (the distance is measured perpendicular to the horizontal ground motion). This reduces the "cross-coupling effect" of the adjacent rows of racks and results in higher displacements and impact forces.

- The impact spring coefficients were set at a value significantly higher (over 10 times) than the calculated value to produce upper-bound impact forces.

Consistent with the above methodology, the single-rack model for this parametric study incorporates the following considerations:

- At the start of the earthquake, the rack was assumed to be 4 inches away from the pool wall and 0.125 inch away from a reference plane (the nominal gap between two adjacent racks is 0.25 inch).

- The adjacent rows of racks were assumed to be an infinite distance away for determining fluid coupling coefficients.

- The impact springs, which represent the sum of all springs in each direction that existed in the 8 degree-of-freedom model described in the Reracking Report, are set at the same level as described in the Reracking Report. For example, spring no. 1 in Figure 1 represents the composite stiffness of the two top and two bottom impact elements (Spring K_w, Figure 6.3.1, Reracking Report).

The Hosgri east-west and vertical ground motions were applied simultaneously to the model, the latter acting to properly account for the vertical weight at the friction interface.

B. <u>Multi-Rack Model</u>

For the multi-rack analysis, a typical east-west section through the spent fuel pool (Figure 2) consisting of four rack modules was selected for evaluation. Parameters for the multi-rack model (Figure 3) were developed in a manner similar to that used for the single-rack model, including mass distribution, friction coefficients, and spring constants. However, the following parameters in the multi-rack model are different:

- The inter-rack gap of 0.25 inch is used as input for the analysis since the use of an assumed reference plane to simulate "out-of-phase" motion of the adjacent racks is not applicable in this analysis.

- In calculating the fluid coupling coefficients, the presence of adjacent rows of racks is accounted for by considering them as vertical planes 7.5 inches on either side of the rack array (versus the nominal 2.25-inch gap between adjacent rack module walls). Analytical studies have shown that the 7.5-inch gap conservatively bounds the coupling effect of adjacent rack arrays.

3. RESULTS OF ANALYSIS

The analyses show that the rack-to-rack impact force calculated for the multi-rack model is approximately 20 percent of that obtained from the single-rack model. As expected, the lower value is attributable to the following characteristics determined by the multi-rack analysis:

- Since all racks are subjected to the same acceleration time-histories, the analyses indicate they do not move completely out of phase with one another.

- The presence of adjacent rows of racks also tends to reduce rack displacements due to their "cross-coupling" effect.

4. CONCLUSION

Based on the above, PGandE's methodology for determining bounding rack impact forces from a single-rack model as described in the Reracking Report is considered to be conservative.

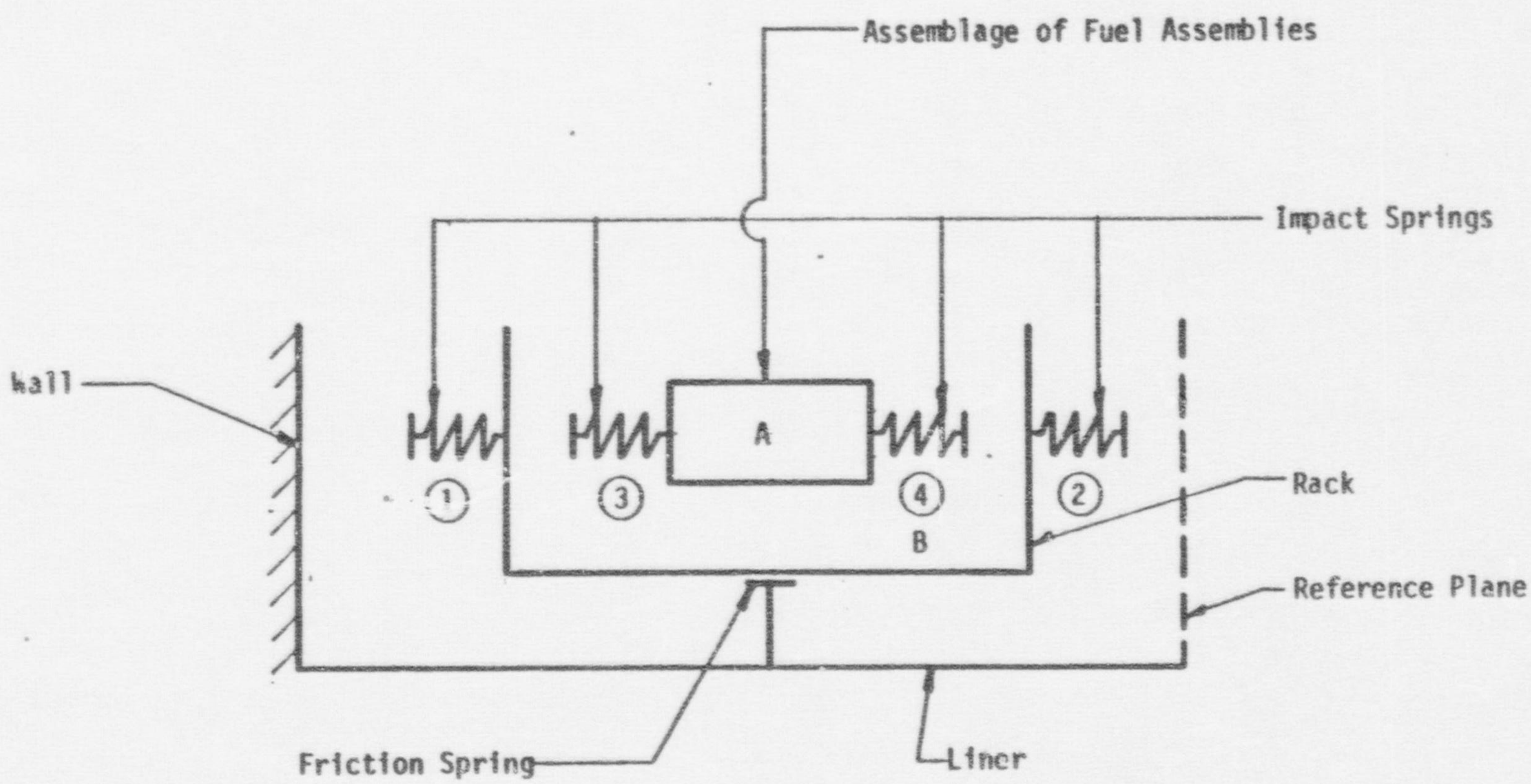

FIGURE 1 TWO DEGREE-OF-FREEDOM SINGLE RACK/FUEL ASSEMBLY MODEL

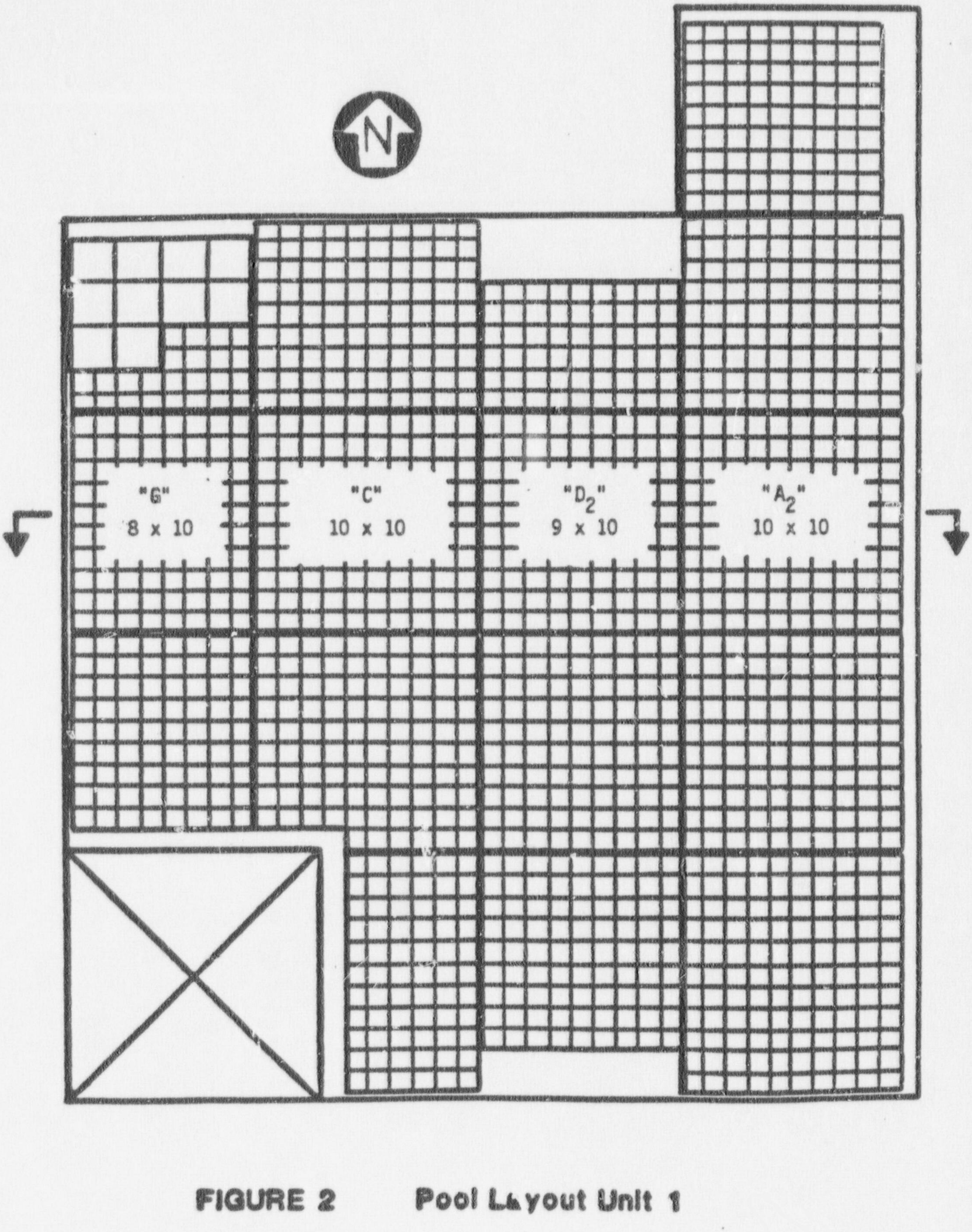

FIGURE 2 Pool Layout Unit 1

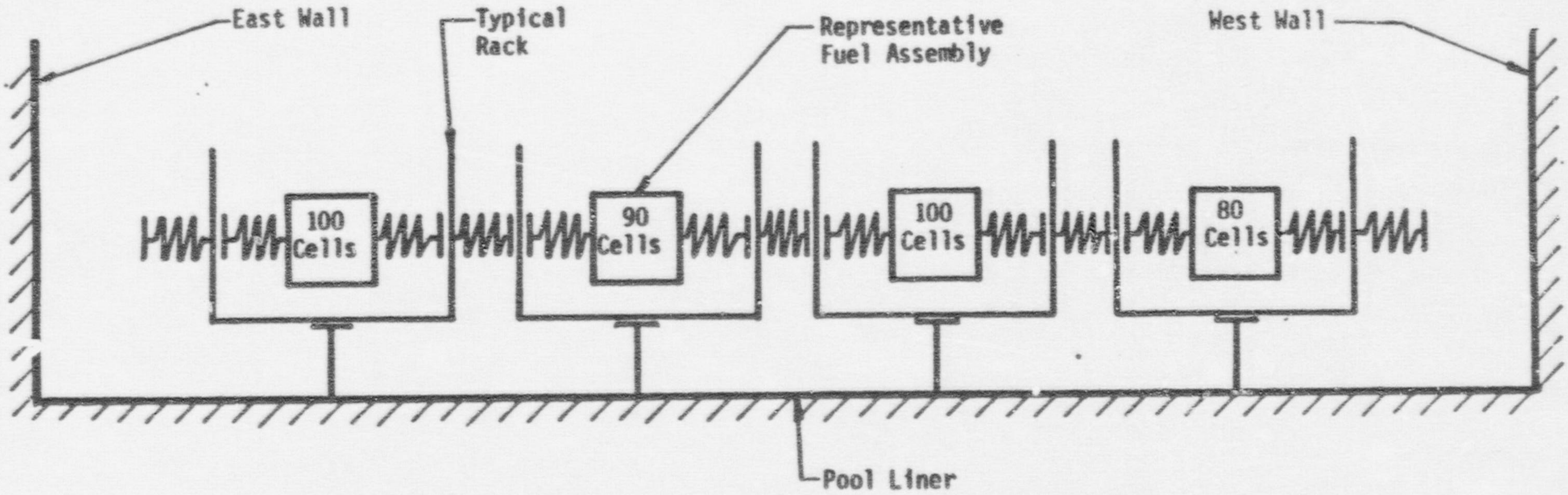

FIGURE 3 MULTI-RACK MODEL, EAST-WEST ARRAY, HOSGRI EARTHQUAKE