March 23, 1999

Mr. Harold B. Ray
Executive Vice President
Southern California Edison Company
San Onofre Nuclear Generating Station
P. O. Box 128
San Clemente, California 92674-0128

SUBJECT: CLOSEOUT OF REVIEW OF SPENT FUEL POOL GATE DROP CALCULATIONS (TAC NOS. M97727 AND M97728)

Dear Mr. Ray:

In a letter dated October 10, 1996, Southern California Edison (SCE, or the licensee) submitted a request for NRC review and approval of a calculation for the drop of a spent fuel pool gate in the spent fuel pool (SFP). The review was a followup to a concern raised during the review of Amendment Application numbers 153 and 137. In the interim period, the licensee committed to not move a SFP gate except in a safe load path, with no fuel assemblies in the drop zone.

During its review, the staff identified several concerns regarding the methodology that the licensee used in its calculations. These concerns are discussed in the enclosure. The staff and the licensee have not been able to reach resolution on these concerns. The staff is therefore closing its review of this issue to provide the licensee the opportunity to evaluate the concerns discussed in the enclosure. The staff understands that the licensee is likely to submit a revised request for this issue at some future time. Until this issue is resolved, the staff expects the licensee to continue to conform to its commitment to not move a SFP gate except in a safe load path.

If you have any questions related to this letter, please contact me at (301) 415-1352.

Sincerely,

Original signed by
James W. Clifford, Senior Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV
Office of Nuclear Reactor Regulation

Docket Nos. 50-361
and 50-362

Enclosure: Calculational Methodology Concerns

cc w/encl: See next page

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Mr. R. W. Krieger, Vice President
Southern California Edison Company
San Onofre Nuclear Generating Station
P. O. Box 128
San Clemente, California 92674-0128

Chairman, Board of Supervisors
County of San Diego
1600 Pacific Highway, Room 335
San Diego, California 92101

Alan R. Watts, Esq.
Woodruff, Spradlin & Smart
701 S. Parker St. No. 7000
Orange, California 92668-4702

Mr. Sherwin Harris
Resource Project Manager
Public Utilities Department
City of Riverside
3900 Main Street
Riverside, California 92522

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
Harris Tower & Pavilion
611 Ryan Plaza Drive, Suite 400
Arlington, Texas 76011-8064

Mr. Michael Olson
San Onofre Liaison
San Diego Gas & Electric Company
P.O. Box 1831
San Diego, California 92112-4150

Mr. Steve Hsu
Radiologic Health Branch
State Department of Health Services
Post Office Box 942732
Sacramento, California 94234

Resident Inspector/San Onofre NPS
c/o U.S. Nuclear Regulatory Commission
Post Office Box 4329
San Clemente, California 92674

Mayor
City of San Clemente
100 Avenida Presidio
San Clemente, California 92672

Mr. Dwight E. Nunn, Vice President
Southern California Edison Company
San Onofre Nuclear Generating Station
P.O. Box 128
San Clemente, California 92674-0128

NRC STAFF CONCERNS REGARDING

SPENT FUEL POOL GATE DROP CALCULATIONAL METHODOLOGY

SAN ONOFRE NUCLEAR GENERATING STATION (SONGS), UNITS 2 AND 3

DOCKET NOS. 50-361 AND 50-362

1. Introduction

In a letter dated October 10, 1996, Southern California Edison (SCE, or the licensee) submitted a request for NRC review and approval of a calculation for the drop of a spent fuel pool gate in the spent fuel pool (SFP). The review was a followup to a concern raised during the review of Amendment Application numbers 153 and 137. The licensee performed an analysis to demonstrate that a dropped pool gate would not damage more than one fuel assembly.

2. Discussion

The licensee evaluated several modes of a potential gate drop, and calculated the penetration depth (or magnitude of deformation) of the rack's upper structure by equating work done by the descending gate to the work done by the structural member of the rack. The rack structure consists of open square channels which maintain the fuel assemblies in a vertical position. The channel walls are 0.11 inch thick stainless steel. The gate weighs about 4000 pounds and is 3/4 inch thick. The gate and rack with fuel assemblies are submerged in the spent fuel pool water. The gate is assumed to drop 30 inches. In the first analysis, the edge of the 3/4 inch thick gate impacts the 0.11 inch thick rack walls. An assumption was made that the wall would deform downward uniformly without tearing or buckling. After penetration, the gate was assumed to tilt sideways and damage only one fuel assembly.

3. Staff Technical Concerns

3.1 One of the licensee's major assumptions is to postulate failure of the rack wall when shear stress in the wall, calculated by a formula provided in the reference, Formulas for Stress and Strain (Young and Roark), Fifth Edition, reaches the yield stress.

The staff has several concerns with this approach. First, it is not clear that the true shear stress in the wall can be represented by the formula provided by the licensee. The formula in the reference is derived from another reference, Theory of Elasticity (Timoshenko and Goodier), Second Edition. There are several formulas in the second reference, and it is not clear which formula is used for the calculation from the first reference, or how the formula was modified for the licensee's calculation. In any event, the formulas in the second reference deal with the assumption of plane stress. For plane stress analysis, an infinite thickness of the body is assumed. This is not appropriate for the rack walls.

Secondly, even if the formula represented the true state of shear stress in the walls, the staff does not consider the calculation conservative since there is also a compressive stress at the point where the shear is calculated. Comparison with other commonly used failure criteria would show that the material will fail at a much lower shear stress and not at the yield stress when a compressive stress is also present (see Advanced Mechanics of Materials, Sealy and Smith, Second Edition).

In addition, once failure is initiated, further progression of the gate's downward movement might require much less stress, since the failure of the wall will introduce stress concentrations. Therefore, assuming a constant load for the work done by the rack wall could result in a significant underestimate of the amount of damage to the walls.

3.2 The licensee used another basic assumption that the wall does not buckle while the gate deforms it. A knife edge type rack wall (thickness of 0.11 inch) impacted by a 3/4 inch thick, approximately 4000 pound, gate will most likely fail by local instability (buckling of the wall), not by shear stress as assumed by the licensee. In this case, the work done by the rack wall will be considerably lower than the licensee's value resulting in larger deformation and larger penetration than those that the licensee calculated.

3.3 The sudden change of the velocity of the falling gate introduces impact forces to the rack wall. These impact forces cause amplification of load. This has not been considered in the licensee's analysis. The licensee's evaluation is based on the assumption that the load of the gate on the rack can be treated as a static load. This does not appear appropriate, since the impact load will be higher than the static load.