UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FROM SECTION XI OF THE ASME CODE

LEAKING REFUELING WATER STORAGE TANK

SAN ONOFRE NUCLEAR GENERATING STATION UNIT 1,

SOUTHERN CALIFORNIA EDISON COMPANY

DOCKET NO. 50-206

1.0 INTRODUCTION

San Onofre Unit 1 reactor is scheduled to be shut down in 1992. The refueling water storage tank (RWSR) at San Onofre Unit 1 is a carbon steel tank located outdoors near the Pacific Ocean. The tank is 34 feet in diameter and 37 feet high with a nominal volume of 240,000 gallons of borated water at ambient temperature. Anchor bolts connect a ring stiffener to the concrete mat under the RWST. Vertical gusset plates are next to the anchor bolts. The area behind the anchor bolts, bounded by the ring stiffener, the gusset plates and the concrete mat, is approximately 12 inches high and 8 inches wide. This tank is epoxy coated on the inside and is painted on the outside. On March 19, 1992, boric acid seepage and crystals were discovered behind one of the 32 anchor bolts at the base of San Onofre Unit 1 refueling water storage tank. Indications of boric acid were identified at eight additional locations behind anchor bolts, but no seepage was noted at these locations. An intensive inspection of the inside and outside of the RWST led to the licensee's conclusion that the cause of the seepage was incomplete application of the external coating at these locations with resultant corrosion of the steel by exposure to the marine environment. The maximum wastage measured from the outside was 0.150 inches, nominal wall thickness is 0.329 inches. Internal pits were discovered that measured about 20 mils deep. These pits did not align with the leaks and were not thought to contribute to the leakage. This tank was installed in the late 1960's and the corrosion was first detected at some point after installation.

NRC Generic Letter 91-18 directs the use of Article IWA-5250 of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code if leaks are discovered in Class 1, 2, or 3 components during normal plant operation. Southern California Edison Company made a submittal dated April 26, 1992, requesting relief from the requirements of ASME Article IWA-5250 for repair of the leaking refueling water storage tank (RWST).

2.0 DISCUSSION

The NRC staff had two major concerns when the RWST issue first arose. The first issue involved leaks in a carbon steel water tank. In many cases, leakage of a carbon steel water tank is an indication that the remaining wall thickness is very thin and that gross failure of the tank may occur. Also, this tank had no internal cathodic protection and accelerated crevice corrosion could have occurred at holidays in the epoxy coating. This concern prompted the licensee to examine the interior of the tank wall using a remotely piloted submersible vehicle with an on-board camera. About 70 pits were observed on the interior of the tank with no evidence of general wall thinning. Ultransonic testing measurements taken using the submersible vehicle indicated that the pits are shallow (about 20 mils deep) and could not be the cause of the leaks. Furthermore, the pits did not appear to align with the observed leaks. The licensee proposed that the leaks were caused by poor surface preparation of the area behind the anchor bolts and subsequent failure of the external coating resulting in corrosion of the uncoated steel by the severe marine environment. The NRC staff concurs with the licensee's analysis.

The second concern was that the leaks had compromised the seismic qualification of the RWST. The licensee conducted an analysis of the RWST to determine the safe shutdown earthquake (SSE) based on a finite element, fracture mechanics analysis. The analysis was submitted to the NRC on June 26, 1992. The licensee used stresses submitted to the NRC on March 31, 1986, that showed that the tank is qualified for modified Housner SSE loads based on A46 methodology where a flexible tank wall is considered in the analysis. The licensee also concluded from the analysis that there is a margin in the tank buckling capacity to resist a SSE. The margin was found to be below the code specified requirement. (Code Case N-248 requires a minimum safety factor of 1.34, whereas the licensee calculated 1.24 for the safety factor.) The licensee justified continued operation of the plant stating that the analysis is conservative. One conservatism is attributed to the fact that a uniform 30 mils reduction of the tank wall is considered for the buckling capacity instead of the average measured pit depth of 20 mils. (It should be noted that the larger wastage of 150 mils below the ring stiffener does not affect the buckling capacity because this area is reinforced by gusset plates.) The staff does not agree with the licensee that the uniform reduction of the thickness for the buckling analysis is the bounding case since buckling of the tank wall may be sensitive to local imperfections. The licensee then proposed that the analysis was conservative by citing ASME Section III, Subsection ND 3332.1, which states that small holes do not require reinforcement. The staff believes that Subsection ND 3332.1, applies to stresses induced by internal pressure and was not intended to apply to buckling situations.

The licensee subsequently performed an additional analysis (submittal to NRC from Southern California Edison Company, "Refueling Water Storage Tank Calculation - SONGS 1," October 1, 1992) whereby a new buckling capacity of the tank was determined based on a methodology approved by the staff for the Unresolved Safety Issues resolution of USI A46. This new value was found to

be higher than the one determined based on ASME Code Case N248, confirming that the safety factor determined previously is conservative. The staff concluded that the tank is acceptable for use in the operation of the plant provided that there is no further degradation of the wall thickness due to corrosion.

Since the calculated compressive stress is approximately 20 percent smaller than the critical compressive stress, the staff concludes that continued operation of the plant is justified for a short time. If power operations continue past December 1992, the tank should be strengthened to resist buckling.

3.0 CONCLUSION

Based on a review of the information provided, the staff has concluded that the cause of leakage in the RWST was severe marine corrosion caused by poor surface preparation and recoating behind the anchor bolts. Significant additional wastage is not expected prior to the 1992 shutdown of the San Onofre Unit 1 reactor. The staff concludes that the seismic buckling analysis may not have covered the most conservative case, but sufficient margin exists to justify short term continued operation. If continued, long-term use of the tank for safety functions is proposed after the anticipated shutdown date, measures to improve resistance to buckling will be required. The staff concludes that granting relief from the requirements of Article IWA-5250 of Section XI of the ASME Boiler and Pressure Vessel Code will not endanger life or property or the common defense and security and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility pursuant to 10 CFR 50.55a(a)(3)(i).

Principal Contributors: G. Kalman
J. Davis
S. Kim

Date: October 28, 1992

The existing buckling margin is sufficient to justify short term power operations and the normal post-shutdown activities leading to reactor defueling. If continued, long-term use of the tank for safety functions is proposed after reactor defueling, measures to improve resistance to buckling will be required. In the interim, your request for relief from the ASME Code through December 1992 is approved.

Sincerely

Original signed by

Theodore R. Quay, Director
Project Directorate V
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

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Safety Evaluation

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Sincerely

George Kalman, Senior Project Manager
Project Directorate V
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
Safety Evaluation

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October 28, 1992

Docket No. 50-206

Mr. Harold B. Ray
Senior Vice President
Southern California Edison Company
Irvine Operations Center
23 Parker Street
Irvine, California 92718

Dear Mr. Ray:

SUBJECT: SAN ONOFRE UNIT 1 REFUELING WATER STORAGE TANK EVALUATION (TAC NO. M83164)

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