June 22, 2000

Mr. William T. Cottle
President and Chief Executive Officer
STP Nuclear Operating Company
South Texas Project Electric
Generating Station
P. O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNIT 1 - REQUEST FOR RELIEF FROM ASME CODE REQUIREMENTS REGARDING REPAIR OF REFUELING WATER STORAGE TANK WITH FLAW INDICATION (RELIEF REQUEST RR-ENG-33) (TAC NO. MA7243)

Dear Mr. Cottle:

By letter dated November 29, 1999, and supplemented by letters dated December 16, 1999, and February 22 and April 5, 2000, the STP Nuclear Operating Company (STPNOC) submitted a request seeking relief from the American Society of Mechanical Engineers (ASME) Code repair requirements for the refueling water storage tank (RWST) with a flaw indication for South Texas Project, Unit 1 (STP-1). Boric acid crystals were first discovered in 1997 at the toe of the weld joining the RWST shell to the baseplate. They were found again at the same location on February 23, 1999, when STPNOC performed a Section XI, Class 2, system pressure test of the RWST. IWA-5250(a) of Section XI of the ASME Code requires that repair or replacement of components having through-wall leakage be performed regardless of the leakage rate. However, since a comprehensive repair program could extend the duration of a refueling outage significantly, pursuant to 10 CFR 50.55a(a)(3)(i), STPNOC requested relief from the ASME Code repair requirements. STPNOC proposed the use of IWB-3142.4, “Acceptance by Analytical Evaluation,” as an alternative so that STP-1 could be operated with the detected flaw in the RWST. Currently, IWB-3142.4 is not specified as the acceptance standard for inservice visual examinations of the STP-1 RWST.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed STPNOC’s request for relief from the ASME Code repair requirements and for the use of IWB-3142.4 as an alternative for continued operation of STP-1 with the detected flaw in the RWST. The staff identified areas in the STPNOC’s evaluation that appeared non-conservative. Therefore, in the staff's independent evaluation, the staff used more a conservative value for the fracture toughness of the RWST baseplate and applied additional margin to account for seismic loads. Based on STPNOC’s analytical evaluation and the staff's independent evaluation, we have determined that it has been demonstrated that the RWST has an acceptable level of quality and safety for one fuel cycle.

Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the alternative proposed in Relief Request RR-ENG-33 to use IWB-3142.4 as an alternative for continued operation with the detected flaw in the RWST in lieu of repairing the STP-1 RWST is authorized until the next refueling outage.

During the next refueling outage, STPNOC should inspect the tank baseplate from inside of RWST to confirm the crack size of the detected flaw and ensure that there are no other flaws resulting from chloride stress corrosion cracking.

The staff's evaluation and conclusions are contained in the enclosed safety evaluation. Should you have questions regarding this relief request, please contact Mr. John A. Nakoski, of my staff at (301) 415-1278.

Sincerely,

/RA/

Robert A. Gramm, Chief, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-498

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FROM ASME CODE REQUIREMENTS ON A FLAW INDICATION

ON REFUELING WATER STORAGE TANK

SOUTH TEXAS PROJECT, UNIT 1

SOUTH TEXAS PROJECT NUCLEAR OPERATING COMPANY

DOCKET NO. 50-498

1.0 INTRODUCTION

By letter dated November 29, 1999, and supplemented by letters dated December 16, 1999, and February 22 and April 5, 2000, the STP Nuclear Operating Company (the licensee) submitted a request seeking relief from the American Society of Mechanical Engineers (ASME) Code repair requirements for the refueling water storage tank (RWST) for South Texas Project, Unit 1 (STP-1). Boric acid crystals were first discovered in 1997 at the toe of the weld joining the RWST shell to the baseplate. Subsequent monitoring indicated no leakage in 7 days; therefore, the licensee concluded in its engineering evaluation that the RWST could be operated with periodic monitoring. On February 23, 1999, the licensee performed a Section XI, Class 2 system pressure test of the RWST, and again, boric acid crystals were found at the same location. Consequently, the licensee concluded that the RWST has a small active leak.

IWA-5250(a) of Section XI of the ASME Code requires that repair or replacement of components having through-wall leakage be performed regardless of the leakage rate. However, since a comprehensive repair program could extend the duration of a refueling outage significantly, the licensee seeks relief from the ASME Code repair requirements and proposes instead to use IWB-3142.4, “Acceptance by Analytical Evaluation,” on the basis that the proposed analytical evaluation would provide an acceptable level of quality and safety so that the unit could be operated with the detected flaw in the RWST.

2.0 EVALUATION

2.1 Applicable Requirements

Federal Regulations, 10 CFR 50.55a(a), require nuclear power facility systems and components to meet the applicable requirements of Section XI of the ASME Code. IWA-5250(a) of Section XI of the ASME Code requires that repair or replacement of components having through-wall leakage be performed regardless of the leakage rate. However, 50.55a(a)(3)(i) permits the use of alternatives to the above requirements if the proposed alternatives would provide an acceptable level of quality and safety. IWB-3142.4, "Acceptance by Analytical Evaluation," of the 1989 Edition of the ASME Code, permits continued service of components containing relevant conditions (indications) if an analytical evaluation demonstrates the component's acceptability. Currently, IWB-3142.4 is not specified as the acceptance standard for inservice visual examinations of the RWST for STP-1.

Components accepted for continued service based on analytical evaluation shall be examined in accordance with IWB-2420(b) and (c). IWB-2420(b) requires reexaminations during the next three inspection periods, and IWB-2420(c) permits reversion to the original schedule if the three successive examinations reveal that the flaws remain essentially unchanged.

2.2 Licensee's Evaluation

2.2.1 Root Cause

The licensee originally attributed the flaw to some porosity in the toe of the weld joining the RWST shell to the baseplate which, when combined with baseplate warpage due to the significant rework during construction and significant shrinkage associated with multiple welds on stainless steel parts, provided a leak path from within the tank. This root cause analysis was later revised in light of information from field inspection and replication. In the submittal dated February 22, 2000, the licensee stated, "[t]his photograph shows the crack initiating from the bottom tank exterior of the plate and propagating up through the thickness. It also shows evidence of transgrannular crack propagation and branching which is characteristic of chloride stress corrosion cracking in austenitic stainless steels."

2.2.2 Flaw Evaluation

The licensee performed a critical flaw size calculation by using the stress intensity factor (applied K) formula for an edge crack in a finite width plate. The input stress of 2.37 ksi for the baseplate was based on the stress of 1.75 ksi from a finite element method (FEM) analysis of the RWST subjected to the hydraulic load. A factor of 1.36 from the original design report was applied to the FEM stress to account for the seismic loads. The fracture toughness of 200 ksi$\sqrt{\text{in.}}$ used in the analysis is a generic value for American Iron and Steel Institute (AISI) 304/304L stainless steel from a National Aeronautics and Space Administration publication. Based on the above, the licensee estimated the critical flaw size to be 314 inches.

For the existing flaw, which was detected on the baseplate outside of the RWST, the licensee believed it would be stopped at the weld of the nearest baseplate lap joint if the flaw ever grew inwardly toward the center of the tank. This qualitative argument was based on the reduced applied K due to the increase of joint thickness (plate + weld) from 1 times the plate thickness to 2 times the plate thickness typical to lap joints. Hence, the licensee estimated the existing flaw size to be 13 inches according to the construction layout. Crack growth due to fatigue has also been considered in accordance with Appendix C of the ASME Code and determined to be insignificant. Since the existing flaw size (estimated at 13 inches) is less than the critical flaw size (314 inches), the licensee concluded that the structural integrity of the RWST is maintained, and STP-1 could be safely operated without repairing the detected flaw in the RWST.

2.3 Staff's Evaluation

Based on the licensee's root cause analysis, the staff concluded that the crack initiation is a combined result of local fabrication defect, residual stresses due to the significant rework during construction, and an aggressive environment. From the metallography, the licensee confirmed that subsequent crack propagation was driven by chloride stress corrosion cracking as evidenced by the transgrannular crack propagation and branching indicated by the replication.

The staff accepts the formula for applied K calculation for the baseplate. However, there are areas in the licensee's flaw evaluation that the staff questioned. First, in the critical flaw size calculation, the factor of 1.36 from the original design report to account for the seismic loads was for the tank sidewall. There is uncertainty in applying this factor directly to the baseplate. To cover this uncertainty in the staff's independent evaluation, the staff applied an additional factor of 1.5 (50% more margin) to the remote stress. Second, lacking a plant-specific test-based fracture toughness value for the baseplate, it is perhaps too optimistic for the licensee to use 200 ksi√in. The staff used 135 ksi√in. in its independent evaluation, which is recommended in Generic Letter 90-05, "Guidance for Performing Temporary Non-Code Repair of ASME Code Class 1, 2, and 3 Piping," for stainless steels. After consideration of the two factors mentioned above, the staff revised the licensee's calculated critical flaw length from 314 inches to 63.6 inches [$314 \times (135/200)^2 \times (1/1.5)^2$]. It should be mentioned that the ASME Code requires a safety factor of 3.0 for the normal and upset conditions and 1.5 for the emergency and faulted conditions for flaw evaluations of detected flaws similar to the current flaw geometry. Although the licensee did not mention the ASME Code safety factors in its submittals, the staff verified from the reported results that a safety factor of 3.0 had been applied in the licensee's calculation.

The licensee estimated the existing flaw size to be 13 inches according to the construction layout, which specified that lap joints be used for welding the baseplate during construction. The staff agrees that most likely the crack is no greater than 13 inches because of the lap joint design. However, it is impossible to provide a precise determination of the crack size because of the lack of inspections. Since the existing flaw size is substantially smaller than the revised critical flaw size as calculated by the staff, the licensee's flaw evaluation with the adjustment by the staff appears to provide a basis for structural integrity of the RWST.

However, the above evaluation applies only to the flaw that was detected by the licensee. Judging from the fact that a tank of 54 feet in diameter is unlikely to have only one local defect, and other cracks could be completely inside the tank, the staff has determined to grant relief for only one fuel cycle, allowing STP-1 to operate with the RWST unrepaired until the next refueling outage. In the next outage, the licensee should inspect the tank baseplate from inside of the RWST to confirm the crack size of the detected flaw and ensure that there are no other flaws inside the tank that are subjected to chloride stress corrosion cracking.

To assure that the RWST can stand seismic sloshing loads, the staff performed a dynamic analysis based on the methodology of the AEC [Atomic Energy Commission] technical information document, TID-7024, "Nuclear Reactors and Earthquakes," 1963. Using the operating-basis earthquake response spectrum (north-south direction) supplied by the licensee, an assumed critical damping value of 0.5%, and the worst possible crack orientation, the staff calculated the applied K for a postulated crack of 13 inches in the baseplate due to the seismic sloshing load to be 11 ksi√in. This value is far less than the fracture toughness of 135 ksi√in.

used in the staff's independent evaluation. Hence, the staff concludes that the RWST could maintain its structural integrity under sloshing loads. Although this analysis assumed that the tank was rigid, a refined flexible-tank analysis is not necessary because the margin from the rigid-tank analysis is large enough to cover the uncertainty caused by the difference in modeling.

3.0 CONCLUSION

The NRC staff has reviewed the licensee's request for relief from the ASME Code repair requirements and for use of IWB-3142.4 for the STP-1 RWST. Based on the licensee's analytical evaluation and the staff's independent calculations, the staff has determined that the evaluation has demonstrated that the RWST would have an acceptable level of quality and safety. However, since the above evaluation applies only to the flaw that was detected by the licensee, and other cracks could be completely inside the tank, the staff has determined to grant relief for only one fuel cycle. Pursuant to 10 CFR 50.55a(a)(3)(i), the alternative should be authorized for one fuel cycle, and STP-1 can be operated without repair of the detected flaw in the RWST until the next refueling outage. In the next outage, the licensee should inspect the tank baseplate from inside of the RWST to confirm the crack size of the detected flaw and ensure that there are no other flaws resulting from chloride stress corrosion cracking.

Principal Contributor: S. Sheng

Date: June 22, 2000

During the next refueling outage, STPNOC should inspect the tank baseplate from inside of RWST to confirm the crack size of the detected flaw and ensure that there are no other flaws resulting from chloride stress corrosion cracking.

The staff's evaluation and conclusions are contained in the enclosed safety evaluation. Should you have questions regarding this relief request, please contact Mr. John A. Nakoski, of my staff at (301) 415-1278.

Sincerely,

/RA/

Robert A. Gramm, Chief, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-498

Enclosure: Safety Evaluation

cc w/encl: See next page

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