Southern California Edison Company
23 PARKER STREET
IRVINE, CALIFORNIA 92718

R. ORNELAS
PLANT LICENSING MANAGER
SAN ONOFRE NUCLEAR GENERATING STATION

TELEPHONE
(714) 454-4550

April 26, 1992

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

Gentlemen:

Subject: **Docket No. 50-206**
Request for Relief from ASME Section XI Articles Applicable to Refueling Water Storage Tank Leakage
San Onofre Nuclear Generating Station Unit 1 (SONGS 1)

NRC's Generic Letter 91-18 directs the use of Article IWA-5250 of Section XI of the ASME Boiler and Pressure Vessel Code for repairs if leaks are discovered in Class 1, 2, and 3 components during normal plant operation. However, we have determined, following the discovery of boric acid seepage in the Refueling Water Storage Tank (RWST) at SONGS 1, that the tank remains operable, and requires no repairs at this time. Therefore, relief is requested from the requirements of Article IWA-5250. The basis for the relief and the proposed alternative are contained in the enclosure.

BACKGROUND

SCE recently discovered a minor seepage of boric acid in a location behind one of 32 anchor bolts along the base of the RWST. Leakage is also suspected at eight other anchor locations where boric acid has been detected chemically, although moisture was not visible. The corrosion damage in the nine locations has been attributed (based upon the information currently available) to incomplete application of external coating at these locations resulting in exposure of the tank plate to the marine environment. Inaccessibility of the locations for proper surface preparation resulted in the improper coating application. This coupled with debris accumulation and impeded drainage resulted in the identified external corrosion.

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REQUEST FOR RELIEF

The NRC has cited ASME Section XI Article IWA-5250 in Generic Letter 91-18 for dealing with operational leakages. Our request for relief from this requirement is based on the detailed information contained in the enclosure and its attachment.

Preliminary results of a detailed RWST evaluation have concluded that the tank continues to meet the required seismic and structural design criteria and that the tank's ability to perform its safety functions will not be compromised by the defects or seepage. The tank is therefore deemed operable. The rate of boric acid seepage through the tank wall is insignificant, and tank makeup for the seepage will not be necessary. Compensatory actions will be implemented to monitor the condition of the tank. The enclosed relief request and its attachment demonstrate that the plant can be safely operated with the tank in its present condition.

COMPENSATORY ACTIONS

To ensure that corrosion does not further degrade the tank wall, SCE will implement several compensatory measures. These include daily visual surveillance of the 32 anchor bolt locations along the base of the tank, daily general inspection of the overall tank exterior, and monthly UT inspections of the areas adjacent to the corroded locations. The tank operability will be re-assessed if a measurable increase in leakage (leakage/drop formation observable to the eye, appreciable ponding/collection of fluid within the stiffener area over a 24-hour period) is detected from the nine existing indications, or if new leakage from the remaining 23 anchor bolt locations is revealed.

FUTURE ACTIONS

In our conversation with the NRC on this subject on April 23, 1992, we indicated the following additional actions will take place:

- Final results of the tank analyses described in the enclosure will be provided in a summary report to be submitted by May 22, 1992.
- A meeting will be scheduled with the NRC staff for the week of May 4, 1992 to have an on-site inspection of the tank and a further discussion of this issue.

- The possibility of further examination of the tank and additional analysis is being explored and will be discussed in our upcoming meeting.

- A sketch of the tank depicting specific locations of the indications is being prepared and will be provided by May 1, 1992.

Please contact me if you wish to discuss this matter further, or if you require any additional information.

Very truly yours,

R. Ornelas

Enclosure

cc: J. B. Martin, Regional Administrator, NRC Region V
George Kalman, NRC Senior Project Manager, San Onofre Unit 1
J. O. Bradfute, NRC Project Manager, San Onofre Unit 1
C. W. Caldwell, NRC Senior Resident Inspector, San Onofre Units 1, 2&3

ENCLOSURE

REQUEST FOR RELIEF FROM PORTIONS OF ASME SECTION XI REQUIREMENTS FOR REFUELING WATER STORAGE TANK AT SONGS 1

Relief Request and Proposed Alternative

Generic Letter 91-18 directs the use of Article IWA-5250 of Section XI of the ASME Boiler and Pressure Vessel Code for repairs if a leak is discovered in a Class 1, 2, and 3 component during normal operation. However, SCE has determined that the Refueling Water Storage Tank (RWST) at San Onofre Nuclear Generating Station Unit 1 (SONGS 1) remains operable, and does not require repairs at this time. Therefore, relief is requested from the provisions of Article IWA-5250. In lieu of repairing the tank, SCE proposes to implement several compensatory measures to ensure that the flaws do not result in further degradation of the tank wall. These measures are discussed below.

Code Requirement

Article IWA-5250, "CORRECTIVE MEASURES," requires that if leakages (other than normal controlled leakages) are detected during the performance of a system pressure test, the source of leakage be located, and the area be examined as appropriate to establish the requirements for corrective action. Component repair or replacement should be performed in accordance with the rules of IWA-4000.

This article is cited in the NRC's Generic Letter 91-18 with regard to maintaining structural integrity following operational leakage. Specifically, the document says: "If a leak is discovered in a Class 1, 2, and 3 component in the conduct of inservice inspections, maintenance activities, or during plant operation, IWA-5250 of Section XI requires corrective measures be taken based on repair or replacement in accordance with Section XI."

Basis for Relief Request

The justification for granting this relief is provided in Attachment A which demonstrates that the RWST in its present condition remains operable, and does not impose a risk to the health and safety of the public. Attachment A also provides a technical basis for the continued operation of the plant with the tank in its present condition.

Compensatory Measures

To ensure that corrosion does not further degrade the tank wall, SCE will implement several compensatory measures. These include daily visual surveillance of the 32 anchor bolt locations along the base of the tank, daily general inspection of the overall tank exterior, and monthly UT inspections of the areas adjacent to the corroded locations. The tank operability will be re-assessed if a measurable increase in leakage (leakage/drop formation observable to the eye, appreciable ponding/collection of fluid within the stiffener area over a 24-hour period) is detected from the nine existing indications, or if new leakage from the remaining 23 anchor bolt locations is revealed.

The RWST has been evaluated to withstand a design basis earthquake of magnitude 0.67g, and a recent analysis has shown that this qualification is not compromised by the existence of localized corrosion on the tank. In addition, SONGS 1 Abnormal Operating Instruction (AOI), S01-2.5-1, "Earthquake," requires performance of a detailed inspection of the RWST, should a seismic event of magnitude 0.05g or greater occur. This operator action will ensure that tank wall integrity will be assessed for a seismic event of a magnitude far less than the tank's design capability.

ATTACHMENT A

EVALUATION OF REFUELING WATER STORAGE TANK THROUGH-WALL LEAKAGE

EVALUATION OF REFUELING WATER STORAGE TANK THROUGH-WALL LEAKAGE

INTRODUCTION

Through-wall seepage of boric acid has been detected at nine locations along the base of the Refueling Water Storage Tank (RWST) at San Onofre Nuclear Generating Station Unit 1 (SONGS 1). Generic Letter 91-18 directs the use of Article IWA-5250 of Section XI of the ASME Boiler and Pressure Vessel Code for repairs if a leak is discovered in a Class 1, 2, and 3 component during normal operation. However, SCE has determined that the RWST remains operable, and does not require repairs at this time. Therefore, relief is being requested from the provisions Article IWA-5250.

The purpose of this document is to provide a description and evaluation of the boric acid seepage through the tank. Included herein are results of inspections performed on the tank and preliminary results of analyses performed following discovery of the seepage. Finally, a justification for the continued operation of the plant is provided.

PROBLEM DESCRIPTION

On March 19, 1992, a wetting of the RWST tank wall was observed between the two stiffener gussets on either side of one of the thirty two (32) anchor bolts on the RWST. The leakage is best characterized as a recurring wet spot with the formation of boric acid crystals at the periphery of the spot. The leak rate is such that a small amount of water accumulates at the base of the tank inside the gusset plates but is too small to quantify (only dampness has been seen with no visible droplets observed). Once the fluid forming the wet spot was confirmed to be borated water, a Nonconformance Report (NCR 92030187) was issued. As part of this NCR, an operability assessment was made which determined that the tank could perform its safety function and therefore was operable.

Subsequent inspections of the exterior of the tank identified external coating damage and/or corrosion products between the gussets at eight (8) other anchor bolt locations. In addition, trace amounts of boric acid were noted at these locations with no active leakage or accumulation of borated water. The areas were cleaned and the boric acid reappeared, thus confirming minute amounts of leakage at these locations. Chemical analysis of the corrosion products in these locations confirmed small amounts of boric acid although moisture was not visible. There is no evidence of leakage at the remaining 23 anchor locations on the tank.

Following the visual inspection, efforts were made to assess the extent of the corrosion damage by ultrasonic (UT) and depth micrometer measurements. It was found that the tank wall thinning is limited to those areas which also showed evidence of corrosion on the outside of the tank. These are the areas inside each of the gusset plates at the nine locations mentioned above. In other areas that showed no external corrosion very little wall thinning was noticed.

The largest corroded or thinned area is approximately 3 inches horizontal by 4 inches vertical. Since the corroded areas are difficult to access and as a consequence cannot be properly prepared, standard ultrasonic thickness measurements could not be employed within the corroded areas. However, depth micrometer measurements taken against a known reference surface of full wall thickness indicated a maximum metal loss of 88 mils from the outside surface of the tank with an average metal loss of approximately 50 mils. The tank nominal wall thickness is 0.329 inches.

PROBABLE CAUSE OF LEAKAGE

The most probable cause of the through-wall leakage is pitting due to the harsh marine environment attacking the carbon steel shell through a degraded external coating. Although there are apparent coating failures in the inner surface resulting in internal corrosion, the ultrasonic inspection done on samples of these pits has shown them to have no appreciable depth. The depth of the maximum pit is 16 mils when compared to nominal wall thickness in the immediate area. This conclusion is substantiated by the consistency between measured corrosion from the inside and the outside and expected referenced corrosion rates. Extensive UT examinations performed at all of the tank anchor locations indicated that the corrosion is confined to localized areas within the gussets. SCE's corrosion expert and the tank vendor have reviewed the inspection data, and preliminarily agree with this hypothesis. FAA is still reviewing the data and will forward a definitive conclusion in the near future. Any findings which differ from these conclusions will be further evaluated by SCE. The tank has been shown to meet its design basis and therefore, does not impose a risk to the health and safety of the public.

POTENTIAL CORROSION MECHANISMS

There are three possible corrosion mechanisms that were evaluated which could result in the through wall corrosion and associated tank leakage.

One mechanism is the failure of the external coating, exposing the carbon steel shell of the tank to the corrosive marine environment. The tank is located within two hundred yards of the ocean and eight of nine corroded areas are located on the west side of the RWST where exposure to corrosive salt air would be more direct. This hypothesis fits the available data. The tank wall area between the gussets is obstructed by the anchor bolt and therefore tends to accumulate debris impacting drainage. The anchor bolts also impede access to the tank shell making it difficult to properly prepare the area for painting. All nine locations have debris and/or paint blocking the drain path between the bottom plates and the anchor studs, permitting the inside area to trap water. Chemical analysis of the debris discovered between the nine gusset plates revealed high concentrations of chlorides as well as paint within the corrosion products suggesting corrosion had been occurring for some time and had not been properly prepared before painting occurred. Accelerated corrosion from the environment would result from a combination of inaccessibility for proper surface preservation, debris accumulation, marine environment, and impeded drainage. According to the NACE Corrosion Engineer's

Reference Book, Second Edition, the corrosion rate of unpainted structural carbon steel exposed to severe marine environments is estimated to be 14 to 18 mils/year.

Another, and less probable through wall corrosion mechanism, is a defect in the interior coating with a pit progressing to the outer surface. This hypothesis assumes that the corrosion mechanism is inside to outside due to the failure of the tank liner and subsequent internal corrosion. The RWST liner was inspected in 1989 and determined to be in satisfactory condition (i. e., there was no documented evidence of any corrosion on the wall of the tank). EPRI data for corrosion rates of carbon steel in borated water at ambient temperature and similar boric acid concentration (2500 ppm) indicate a rate of approximately 2 mils/year although rates could be slightly higher for pin size holes in the liner. UT examination of selected corrosion areas identified inside the tank indicate a maximum wall loss of approximately 11-16 mils when compared to the nominal wall thickness in the general area. This supports a scenario of minor wall coating loss and internal corrosion some time after the 1989 internal tank inspection. However, the corrosion rate when coupled with the satisfactory tank inspections in 1989 do not support internally initiated through wall corrosion as the sole contributor to the RWST leakage. In addition, almost all of the internal corrosion spots are located outside of the gussets of the nine flawed areas. Two internal floor plate UT readings in the area where the coating was found missing indicate no degradation in plate thickness. For these reasons, internal corrosion could only be considered a minor contributor to the tank leakage at best.

During a telephone conversation, the NRC expressed a concern that crevice cracking might result in a higher rate of corrosion than that postulated by SCE. The difference in these postulated rates is currently being evaluated and will be addressed at the upcoming NRC/SCE meeting.

Microbial Corrosion (MIC) was considered as a third potential corrosion mechanism, but was ruled out as a possible contributor to the corrosion based on internal inspection of the tank. The corrosion spots which can be seen inside the tank are bright red indicative of iron oxide. In contrast, MIC corrosion typically forms dark brown or black spots; furthermore, this type of corrosion is mainly a problem in fresh and salt water systems where bacteria can really grow.

INTERNAL INSPECTION RESULTS

In an effort to determine the actual root cause of the through wall corrosion, in-house corrosion/metallurgical experts, an outside corrosion expert from Failure Analysis Associates (FAA), and an engineer from the tank Vendor (Pittsburgh Des Moines) were brought onsite for inspection and evaluation. In continuing to pursue the root cause of the corrosion, an inspection of the internal surface of the tank was performed using a remotely piloted submersible vehicle with an on-board video camera. This inspection revealed approximately seventy small, randomly dispersed corrosion pits on the side of the tank with small iron oxide comet trails. Subsequent UT results of some of these corrosion pits taken from the outside of the tank revealed limited wall thinning (16 mils maximum when compared to the nominal wall thickness in the areas measured). Figure 9-3 of EPRI Guide NP-5769 defines a corrosion rate of approximately 2 mils per year for several low alloy steels in air saturated boric acid and water. The tank was last inspected in 1989 with no signs of internal wall corrosion. If it is assumed that the corrosion started in 1989, the expected wall thinning would be 6 mils. The difference between the observed corrosion and the EPRI results can be explained by the slightly higher concentration of corrosion products associated with pin hole type imperfections in coatings.

The internal inspection revealed three corrosion indications along the floor-to-wall weld, approximately 2" long. These indications are on the east side of the tank well away from any leakage locations and are believed to be pin hole imperfections in the liner similar to those discovered on the wall. There is no visual evidence that there is any wall thinning in these areas and these spots are considered acceptable.

In addition to identifying randomly dispersed coating failure pits, a small amount of settled debris and a strip of coating material was identified resting on the bottom of the tank. The settled debris had the appearance of small flakes of rust or dirt, and appeared to have a fairly low density because of the ease at which the submarine propeller disturbed the debris. Once disturbed, the debris slowly settled back to the tank bottom. In the event of an actuation of the safety injection system, a fraction of the small rust or dirt flakes is expected to be drawn into the pump suctions, but is expected to be pulverized by the turbulent flow. These particles will not have any adverse effect on safety related equipment.

The strip of coating material measuring about sixteen inches long and one inch wide was found in the tank and determined to have peeled off a weld seam on the floor of the tank in the northwest quadrant. The amount of rust observed at the location where the strip peeled off from was very limited. In 1989, repairs were made to locations on the bottom of the tank. It is suspected that the foot traffic on the bottom of the tank induced a failure at this location in the tank. The visual inspection of the tank floor revealed indications similar to those found on the tank wall. Therefore, it is reasonable to assume that the floor corrosion is of the same type as that on the wall. As discussed in our recent call with the NRC, we are investigating details of the tank foundation to address the possibility of leakage in this area.

The limited amount of rust in the weld area is indicative of the limited time the carbon steel has been exposed to the tank fluid. Based on an expected corrosion rate of approximately 2 mils per year (boric acid to carbon steel) and the fact that the indication appears relatively new, the tank bottom has sufficient margin to operate through the remainder of the year. The section of delaminated coating was successfully removed from the tank for inspection, although the coating material broke apart after it was removed even with gentle handling. Because of the brittle nature of the material, it is also expected to disintegrate in the safety system pumps, and therefore would not impair safety system function.

REFUELING WATER STORAGE TANK SPECIFICATIONS

The RWST is a carbon steel welded tank that was fabricated in 1965 in accordance with API 650. The tank is 34 feet in diameter and the shell height is 37 feet with a nominal volume of 240,000 gallons. The tank plate is A-283 Grade C carbon steel of thicknesses 0.329 inch at the bottom plate ring and 0.250 inch for the remaining plate rings. The tank floor has a thickness of 0.3125 inches. The tank is lined with a Plasite 7155 coating for corrosion protection on the interior and is painted for exterior protection.

ANALYSIS RESULTS

Seismic Analyses

The tank was seismically analyzed in 1986 as part of the seismic reevaluation program. The results of this analysis, submitted to the NRC on March 31, 1986, showed that the tank was qualified for modified Housner SSE loads based on a 0.67g ground acceleration. The analysis concluded that the tank and its foundation were qualified according to the criteria of the ASME and ACI Codes, and that no modification to the tank or foundation was required. Based on their review of this analysis and an independent confirmatory analysis of the tank, the NRC concluded in its safety evaluation that the RWST will withstand the seismic loads induced by a postulated 0.67g seismic event.

New seismic analysis was performed to evaluate the effects of the observed flaws. This analysis utilized the loads from the 1986 design calculation for a detailed local stress analysis at selected locations (i. e., at a bolt location and the thinned shell locations above and below the stiffener ring on the tank shell). Preliminary results of this analysis demonstrate that the tank integrity is maintained. In addition to this analysis, a structural analysis was performed to calculate local loads and stresses to determine if these stresses are below allowables, and a fracture mechanics analysis was performed for a bounding crack size. The structural analysis included a buckling evaluation. These analyses are discussed below.

Structural Analysis

As mentioned above, a design calculation was performed to assess the structural integrity of the tank with known seepage and wall thinning. Stresses were calculated using finite element analysis. Results of this evaluation were used to perform a shell evaluation in accordance with the ASME Section III Code, and a fracture mechanics evaluation to determine the limiting crack size.

The finite element program, ANSYS, was used to calculate the membrane and membrane plus bending stresses in the tank shell for both Design (gravity, hydrostatic pressure and other mechanical loads) and Level D (Design, SSE and hydrodynamic pressure due to an earthquake) conditions. Since there are 32 anchor bolts holding the tank to its foundation, a three-dimensional model was developed representing an 11.25° (360/32) sector which includes one bolt.

The model included the stiffener ring, bottom and all anchorage components. The model was extended to a height of 36" above the concrete foundation to keep the boundary sufficiently removed from the zone of interest. Results of this analysis were obtained in the form of membrane and membrane plus bending stresses in the hoop and longitudinal directions. These stresses were used as input for the ASME Code evaluation of the shell and the fracture mechanics evaluation.

Tank shell evaluation below the stiffener ring was performed per ASME Section III, Subsection ND-3800. Results were obtained for the shell nominal thickness, and for a reduced thickness to account for the wall thinning due to corrosion as indicated by the UT examinations. The preliminary result of this evaluation for the thinned locations are presented in Tables 1 and 2 for the shell above and below the stiffener ring respectively. Tank bottom plate stresses are less than shell stresses and are therefore acceptable.

Membrane stresses in the shell below the stiffener ring in the hoop and axial directions were calculated for gravity, hydrostatic pressure, hydrodynamic pressure (due to seismic movement), and seismic loadings. These stresses were used as input into the computer program PCCRACK to calculate the stress intensity factor as a function of crack size. The crack size corresponding to the critical stress intensity factor (25 ksi $\sqrt{in}$ as given in GL 90-05) represents the largest stable crack under the given stress conditions. The preliminary results of this evaluation determined that a maximum stable crack in vertical direction would be 4" and 6" in the horizontal direction.

Buckling Evaluation

This evaluation was performed for the section of the shell above the stiffener ring, where the tank shell is not reinforced. The section of the shell below the stiffener ring is reinforced by 64 gussets that prevent gross buckling of the tank. The methodology used is based on Code Case N-284. The Code Case assumes that compressive stress is uniform throughout the cross section of the tank. This assumption is extremely conservative, since the compressive stresses in this case are due to an overturning moment resulting from a seismic load where the stress fluctuates from maximum compressive to zero to maximum tension.

Using this conservative methodology, and a reduced shell thickness of 0.30 inch (conservatively bounding localized corrosion depths found in this area and allowing for potential future corrosion), the stresses and the factor of safety were calculated as follows:

Compressive stress allowable, S_{cr} = 8.94 Ksi

Maximum Compressive stress, S = 7.7 Ksi

Factor of Safety, FS = 1.16 <1.34*

* Recommended by the Code Case

Based on the conservative methodology used, and the assumption that the tank shell is thinned uniformly to 90%, these results are considered to be acceptable.

TABLE 1: Results for Reduced Wall Thickness(1) - Below the Stiffener Ring

Service Limit	Stress Limit	Max. Normal Stress, σ_1 (ksi)	Allowable (ksi)	Ratio
Design	σ_m $\sigma_m + \sigma_b$	7.6 11.3	12.7 19.1	1.66 1.69
Level D	σ_m(2) $\sigma_m + \sigma_b$	23.75 29.04	25.4 60.0	1.07 2.06

(1) Reduced wall thickness = 0.329 - 0.088 = 0.241", corresponding to maximum metal loss of 0.088".

(2) σ_m contains local effects due to stiffener ring and gussets and is conservatively used to represent general membrane stress.

TABLE 2: Results for Reduced Wall Thickness(1) - Above the Stiffener Ring

Service Limit	Stress Limit	Max. Normal Stress, σ_1 (ksi)	Allowable (ksi)	Ratio
Design	σ_m $\sigma_m + \sigma_b$	11.1 11.5	12.7 19.1	1.15 1.67
Level D	σ_m(2) $\sigma_m + \sigma_b$	24.5 24.22	25.4 60.0	1.04 2.47

(1) Reduced wall thickness = 0.329 - 0.030 = 0.299", corresponding to metal loss of 0.030".

(2) σ_m contains local effects due to stiffener ring and gussets and is conservatively used to represent general membrane stress.

JUSTIFICATION FOR CONTINUED OPERATION (JCO)

As discussed earlier, the RWST with the flaws and corrosion has been shown to meet its design basis, and therefore does not impose a risk to the health and safety of the public. The following discussion constitutes a technical basis for the continued operation of the plant with the tank in this condition. The items included below are consistent with the NRC guidance provided in Generic Letter 91-18 for consideration in the development of a JCO.

Availability of Redundant or Backup Equipment

The RWST does not have a redundant supply of water from any source for accidents requiring Safety Injection or Containment Spray. The RWST is the sole source of water for these systems. The charging system can be supplied from the Spent Fuel Pool via a manual valve line up. The Spent Fuel Pool is capable of supplying sufficient water for safe shutdown of the plant (normal charging alignment) but is not designed for the higher flows provided by the charging system in its post-LOCA alignment.

Compensatory Measures Including Limited Administrative Controls

Indications of boric acid have been confirmed at nine locations behind the anchor bolts along the base of the Refueling Water Storage Tank (RWST). Compensatory actions to assess the status of RWST over time will be accomplished through visual monitoring of the tank, and periodic UT examinations of areas adjacent to the corroded areas. In addition to monitoring, the condition of the tank will be stabilized by preservation of the current corroded locations by preparing and painting in accordance with SCE painting procedures.

Of the 32 anchor locations, one location has active weepage, as indicated by the external surface wetting though no visible leakage or drippage is present; at eight other locations, leakage is suspected only by chemical detection of boric acid. To remain apprised of possible further tank degradation, a daily visual surveillance of all 32 anchor bolt locations, a daily general inspection of the overall tank exterior, and monthly UT inspections of the areas adjacent to the corroded areas will be performed. Should a measurable increase in leakage be detected (leakage/drop formation observable to the eye, appreciable ponding/collection of fluid within the stiffener area over a 24-hour period), the tank operability will again be evaluated.

The overall effect of the existing observed leaks behind the anchor locations on the structural integrity of the tank is acceptable as discussed previously. However, should the results of the surveillance of the 32 anchor locations reveal new leakage from one of the 23 non-leaking locations, the tank operability will be re-evaluated.

Existing Abnormal Operating Instruction (AOI), S01-2.5-1, "Earthquake," provides guidance and action to operations to diagnose, correct and recover from an earthquake. The AOI directs operations to perform a detailed inspection of the RWST should a seismic event of 0.05g or greater occur.

Seismic events of 0.25g or stronger presently require a plant shutdown and cooldown to cold shutdown. These operator actions, taken in response to a seismic event of far less significance than the tank's design capacity, conservatively monitor and control conditions with regard to the structural integrity of the RWST. The RWST has been evaluated to withstand a design basis earthquake of magnitude 0.67g, and a recent analysis has shown that even with the existing conditions this qualification is not compromised.

Safety Function and Events Protected Against

The RWST's safety function is to provide a highly borated source of water for Safety Injection, Containment Spray and a reserve supply for the Chemical and Volume Control System. The events evaluated in the UFSAR that require the RWST as a source of water are those events that Safety Injection or Containment Spray are credited with mitigating the consequences of the event. Safety Injection is credited for mitigation of all loss of coolant accidents (LOCA), inadvertent opening of pressurizer safety relief, steam line breaks, feed water line breaks and steam generator tube rupture. Containment Spray is credited with mitigating all LOCAs and inside containment steam line breaks including feedwater line breaks at the steam generator. The RWST is also credited as a source for spent fuel pool make-up.

The charging system is required to complete the injection process from the RWST to facilitate transfer to recirculation and is used for long term core cooling following LOCA events. The UFSAR event analyses do not specifically credit charging because the analyses are terminated shortly after peak clad temperatures are reached. The RWST is credited as the borated water supply to the charging system whenever cold leg injection is aligned in the emergency and abnormal event operating procedures. A secondary function of the RWST is to supply an alternate source of borated water to the charging system on loss of supply from the volume control tank (VCT). Suction supply to the charging pumps is transferred to the RWST automatically on low VCT level. As a backup to the VCT, the RWST is the seismically qualified source of borated water for safe shutdown following a DBE.

Conservatism and Margins

A calculation was performed to quantitatively assess the RWST's volume requirements to ensure the tank's safety functions were met. Conservatively assuming the worst case single failure and accident conditions the margin of inventory in the tank is 7,000 gallons. The existing seepage will not compromise this margin.

Preliminary structural and fracture mechanics analyses have produced acceptable results, demonstrating that the tank structural integrity is maintained. A more detailed discussion of the methodology and design margin is contained in the Analysis Results section.

Probability of Needing the Safety Function

The Unit 1 Refueling Water Storage Tank (RWST) is needed to provide a supply of borated makeup water to the Reactor Coolant System (RCS) in events which reduce the RCS inventory and result in a makeup requirement exceeding that provided by the Chemical and Volume Control System (CVCS). The events which could result in this need include: small-small loss-of-coolant accident (LOCA) (dominated by a reactor coolant pump seal failure), small LOCA, large LOCA, steam generator tube rupture, main steam line break, and feedwater line break. The cumulative probability of these events is estimated to be 4E-2 per year, taken from the draft Unit 1 Individual Plant Examination (IPE). The probability of these events occurring prior to end of the present cycle, assumed to be approximately 7 months, is estimated to be 2E-2.

PRA or Individual Plant Evaluation Results that Determine How Operating the Facility in the Manner Proposed in the JCO Will Impact the Core Damage Frequency

Based on preliminary analysis, the capability of the RWST to withstand a design basis earthquake (i.e., 0.67g peak ground acceleration) or less without suffering a major leak or failure is not impacted by the known structural indications in the tank. While the ultimate strength of the tank is reduced by the indications, its capability to withstand design basis or smaller seismic events is not affected. Furthermore, given that the seismic capability of other safety related plant components is unknown for seismic events beyond the design basis, the loss of seismic capability of the RWST beyond its design basis is not a significant contributor to core damage.

The present leak rate of the RWST through the known indications established only by analysis of small boric acid crystal deposits and the observance of wetting of a small section of the tanks exterior. Actual flow cannot be observed and no effect on tank inventory is being experienced. The potential for increase in leak rate due to ongoing corrosion is not expected to result in a requirement for tank inventory makeup prior or the end of the current fuel cycle. Therefore, the core damage impact of operating with the known indications through the end of the current cycle is negligible.