UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REVIEW OF PROPOSED ALTERNATIVE TO THE ASME CODE

FOR REPAIR OF REFUELING WATER TANK BOTTOM AT

ST. LUCIE UNIT NO. 1

FLORIDA POWER AND LIGHT COMPANY

DOCKET NO: 50-335

TAC NO. M90762

1.0 BACKGROUND

By letter dated November 16, 1994, Florida Power and Light, (the licensee), proposed an alternative to the ASME Code for repairing the bottom of the Refueling Water Tank (RWT) at St. Lucie Unit #1. During the ongoing refueling outage, the RWT bottom was inspected due to indications that a small leak had developed. It was discovered that the underside of the tank bottom had numerous dime-sized or smaller corrosion pits. Investigation of the cause of the pitting is ongoing.

The leak was due to a corrosion pit through a plate in the tank bottom. A 15-inch square section of the bottom, containing the leak location, was removed for examination. Upon inspection, the leak was confirmed to be due to a corrosion pit originating from the underside of the plate. Two other pits were also noted in the sample, but they had not perforated the plate. The rest of the plate material was relatively unaffected. Only a slight amount of surface corrosion had occurred away from the pits. The largest pit had a maximum diameter of a dime, tapering to a smaller size as it progressed into the plate. The pit associated with the leak was pin-hole size where it perforated the plate.

The RWT was fabricated from ASTM B209 aluminum alloy, grades 6061-T6 and 6061-T651. It has a height of 39 feet and a diameter of 50 feet, with a capacity of 525,000 gallons. The shell (tank wall) plates at the base are 0.8" thick. The tank floor, which is 0.25" thick, and the shell are welded to a 0.375" thick annular base plate. The tank wall is supported on a reinforced concrete ring foundation. The tank base is anchored to the concrete foundation with 45 two-inch diameter ASTM A36 carbon steel anchor bolts. The bottom of the tank is continuously supported on an oiled sand bed which is enclosed by the concrete ring foundation.

The RWT contains sufficient water to fill the refueling canal, transfer tube and refueling cavity above the reactor vessel. It is also the source of borated water for the emergency core cooling system.

Internal inspection of the RWT may only be accomplished during periods when the tank can be drained due to the presence of an oxygen-excluding bladder in the tank. This bladder precludes access by divers or remotely controlled submersibles.

A Code repair was attempted by replacing a section of the tank bottom. After welding in the new section, several pin holes were noted at the weld toe or in the adjacent material. It was concluded that the welding had either burned through one or more pits or the weld shrinkage had opened the pits and caused pin-hole perforations which were detected during the dye penetrant and vacuum box tests. Due to this difficulty, a Code repair was discontinued while other options were considered.

Due to preparation, material procurement, and installation times, the licensee determined that an in-kind (Code) replacement of the tank bottom would affect the outage schedule by several weeks. Additionally, the licensee determined that an in-kind replacement of the bottom without the benefit of a root cause analysis and incorporation of appropriate countermeasures would not result in an effective long-term solution.

Consequently, the licensee sought to perform an interim repair by installing a fiberglass reinforced vinyl ester liner over the existing aluminum bottom. The licensee contended that such a liner would provide an acceptable level of quality and safety, with an anticipated life of up to 15 years. The lining would be inspected during each refueling outage to ensure its integrity.

2.0 DISCUSSION

In an above-ground tank such as the RWT, the bottom plates have no structural role; they merely act as a fluid boundary. This is because the bottom plates are entirely supported by the sand bed continuous support. The only normal load on the bottom is the static compressive load from the hydrostatic head of the fluid level. In this case, the maximum compressive load on the bottom would be approximately 16 psig, assuming a full tank. The shell of the tank (wall) is designed to independently resist the hoop stress loads of the fluid pressure. Thus, no loads are transferred between the wall and the bottom.

The corrosion observed on the underside of the tank bottom can be characterized as about 2 dime-sized or smaller, part through thickness pits per square foot. The rest of the material has only minor surface corrosion resulting in minimal loss of thickness. Thus the bulk of the bottom material is unaffected by corrosion. Due to the local nature of the corrosion (pitting), the overall structure of the tank bottom is unaffected.

The effect of seismic loads upon the pitted bottom was considered. In the original tank design, the bottom was not considered or designed as a seismic load-resisting component of the tank. Seismic loads arise from the sloshing liquid inside. This acts as an unbalanced horizontal load upon the tank walls. The resulting forces tend to slide the tank sideways or tip it over.

These loads are resisted by the 45 anchor bolts distributed around the tank base. The tank floor continues to be loaded, although unevenly, in compression. No significant horizontal loads occur in the floor.

To prevent further occurrences of leakage, the licensee proposed the addition of a tank bottom lining composed of fiberglass reinforced vinyl ester. Vinyl esters are a tank lining material that have had extensive application in water and chemical tanks constructed of steel. There is no chemical compatibility problem with borated water. Application of a vinyl ester over an aluminum substrate presents no unusual problem.

The proposed lining would essentially be a formed-in-place fiberglass tank bottom. It would be bonded to the existing bottom and extended two feet up the tank walls following grit blasting of these areas. After application of a vinyl ester primer, the nominal 1/8-inch lining would be built up. This would consist of a 1/16-inch thick silica-filled vinyl ester base coat, a single layer of woven roving fiberglass cloth, and a 1/16-inch thick silica-filled vinyl ester top coat.

A reinforced lining was chosen over a conventional (unreinforced) lining because of anticipated future pit formation in the aluminum plates beneath it. Addition of the fiberglass would allow the lining to bridge a 0.5" diameter hole without cracking or leaking. No pits of such size are known to exist in the tank bottom. None of such size would be reasonably expected to occur for the anticipated duration of the repair.

Potential consequences of lining failure were considered. Lining failure by way of cracking or disbondment would not result in large sheets of material dislodging and plugging suction lines. The presence of the reinforcing fiberglass prevents break up of the vinyl ester into large sheets by providing a continuous tensile reinforcement. Disbondment of the liner from the tank bottom would not be expected to occur because of the strong adhesion of the coating. If it did disbond, the material is denser than water and would remain in place. The RWT suction line is 2 feet above the tank bottom. Consequently, the flow velocities at the tank bottom are slow and no strong currents occur to draw debris off the tank bottom. Additionally, the coating will be brought 2 feet up the tank wall, thus assuring a tie-in to the unaffected structure of the tank and complete sealing of the bottom.

Usable tank inventory is unaffected. This is because the suction lines are 2 feet from the tank bottom. The tank volume lost due to the application of the lining will only affect that portion below the suction lines.

3.0 STAFF EVALUATION AND CONCLUSIONS

The staff finds that the condition of the RWT bottom, although locally degraded and susceptible to pin-hole leaks, is structurally acceptable for continued service. Consequently, the staff finds the proposed alternative to an ASME Code repair for the RWT bottom would provide an acceptable level of quality and safety. The proposed lining is a coatings industry standard with demonstrated capability for the intended application.

In accordance with the provisions of 10 CFR 50.55a(a)(3)(i), relief is granted to install and use the proposed tank lining, in lieu of a Code repair or replacement, until the scheduled steam generator replacement outage currently planned for St. Lucie Unit #1 in 1998. At the time of the steam generator replacement outage, the RWT bottom shall be repaired or replaced in accordance with the ASME Code. Additionally, the licensee has committed to perform a visual examination of the coating during each refueling outage, continue monitoring the tank for indications of leakage, and complete ongoing laboratory testing to confirm the ultimate capabilities of the lining.

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