UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

September 13, 2013

NRC INFORMATION NOTICE 2013-18: REFUELING WATER STORAGE TANK DEGRADATION

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power plant issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of and applicants for a power reactor early site permit, combined license, standard design certification, standard design approval, or manufacturing license under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Reactors."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of potential issues associated with leakage due to flaws in refueling water storage tanks. The NRC expects recipients to review the information for applicability to their facilities and consider taking action, as appropriate. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

Kewaunee Power Station

The refueling water storage tank (RWST) at Kewaunee Power Station is a stainless steel tank of welded construction with a capacity of 272,500 gallons that is located in the auxiliary building. On July 10, 2012, the licensee identified a boric acid deposit adjacent to the weld connecting the tank wall to the floor plate. No actual leakage of water from the tank was observed. The licensee postulated that the boric acid deposit was due to a pinhole leak that resulted from an original weld defect or some form of stress corrosion cracking, e.g., chloride stress corrosion cracking. The licensee justified continued operation of the tank through the use of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Case N-705, "Evaluation Criteria for Temporary Acceptance of Degradation in Moderate Energy Class 2 or 3 Vessels and Tanks," until permanent repairs could be made to the tank.

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Palisades Nuclear Plant

The Palisades Nuclear Plant safety injection refueling water tank (SIRWT[1]) is an aluminum tank of welded construction with a capacity of 300,000 gallons that is located on the roof of the auxiliary building. The tank was constructed in accordance with ASME Standard B96.1, Welded Aluminum-Alloy Storage Tanks, which is inactive and has no replacement. Part of the tank is located directly above the control room. Numerous pipes exit the floor of the tank through nozzles.

Leakage into the auxiliary building concrete roof structure (catacombs) was observed beginning in the spring of 2011. Despite repair efforts in 2012, leakage from the tank, sometimes accompanied by rainwater leaking through the roof around the tank, was present until the majority of the tank floor was replaced during the summer of 2013.

Inspection and repair efforts revealed the following issues:

1. Inspections were conducted using visual, surface and electromagnetic techniques. These techniques revealed numerous flaws in the tank floor welds and floor to shell weld seam. Some flaws in the floor plates were also identified. These flaws were generally associated with arc strikes and/or spatter, were not through wall, and may have been original construction defects.

2. Through wall defects (leaks) were located in the tank floor welds. Some of these defects were associated with tank floor to penetration nozzle welds. As part of the repair process the penetrations were redesigned to improve nozzle strength and to permit the nozzles to move in response to flexing of the tank floor.

3. ASME Standard B96.1 does not contain specific guidance for the construction of tank floor penetration as used in this tank.

4. Leakage from the tank recurred in 2013, requiring plant shutdown. This leakage was attributed to the failure of a nozzle repair weld made in 2012. A destructive evaluation of the weld indicated significant lack of fusion that could be the result of inadequate cleaning of the weld surfaces, and/or low weld heat input.

5. Design drawings for the tank indicated that the tank shell was supported by a concrete ring foundation and that the tank floor rested on a sand bed. During tank floor replacement in 2013 it was determined that neither the ring foundation nor the sand bed was present. Given that the entire tank bottom sits on the concrete roof structure of the auxiliary building, these differences in the “as designed” and “as built” tank are not structurally significant.

6. Some of the nozzles which were encased in concrete exhibited denting. Denting appears to be the result of a two-step process. In the first step aluminum corrodes as a result of contact with moist concrete. In the second step, the resulting corrosion products, which are more voluminous than the metal from which they are formed, force the nozzle inward.

[1] SIRWT is a site-specific term that is essentially equivalent to the generic term RWST.

South Texas Project, Unit 1

The RWST at South Texas Project, Unit 1, is an ASME Code, Section III, Class 2 seismically-qualified stainless steel tank of welded construction with a capacity of 550,000 gallons. It is located inside the Unit 1 auxiliary building and has drains connected to the radioactive drain waste collection system. In September 1997, the licensee observed a spot of rust, traces of moisture, and some boric acid crystals at the RWST floor to tank wall weld. Since no actual leakage of water was observed, it was initially suspected the boric acid residue may have come from a tank connection above this location. Based on an engineering evaluation, the licensee initiated a periodic monitoring program of the RWST but took no additional action.

In February 1999, the licensee observed boric acid crystals in the same location as identified in 1997. The licensee performed a failure analysis using in-situ replication metallography and determined that the observed boric acid crystals were the result of a through wall crack at the base plate weld (tank floor to tank shell). Additionally, the licensee determined that the crack was transgranular and branched, consistent with chloride stress corrosion cracking.

In 2001, the licensee performed a visual examination from the inside of the RWST using a video camera on a remotely controlled submersible device. No evidence of base plate or side wall cracking was observed, and no repairs were performed. Periodic monitoring of the exterior of the tank continued.

In September 2011, boric acid residues were discovered under the base lip of the RWST in two new locations near the RWST discharge line. Following discussions with the NRC, STP conducted the necessary calculations to demonstrate the structural adequacy of the tank in accordance with ASME Code Case N-705. The licensee made repairs to the tank in accordance with the ASME Code, Section XI, in the fall of 2012.

BACKGROUND

RWSTs serve the dual purpose of supplying water to flood the refueling cavity during refueling operations and supplying water to the emergency core cooling system and the containment spray system in emergency situations. RWSTs are fabricated from stainless steel or aluminum to minimize corrosion resulting from the borated water stored in the tank. These tanks are generally classified as ASME Class 2 for purposes of inspection. Leaks from the tanks may result in failure to meet the tank's intended safety function due to loss of inventory, contamination of soil and or groundwater due to release of tritium to the environment, and/or damage to safety related equipment due to water spray or flooding.

DISCUSSION

The above events demonstrate that leaks from RWSTs can result in disruption of plant operations. Based on the above events, the NRC believes that the following observations may be of value to licensees:

1. Tank inspections have determined that all of the leaks have occurred in welds which are in or near the bottom of the tank.

2. Although additional degradation modes appear possible, the subject leaks have been attributed to weld fabrication flaws, stress corrosion cracking, and/or high stress low cycle fatigue.

3. The degradation mechanisms which have been identified are not those described for above ground tanks in NUREG 1801, the Generic Aging Lessons Learned (GALL) Report (ADAMS Accession No. ML103490041). Based on the events cited, the NRC is considering whether modifications to the GALL Report are warranted.

4. Although the events described in this IN resulted in leakage, none of the events has challenged the structural integrity of the tank.

5. As demonstrated by two of the events described above and documented in IN 2012-20, "Potential Chloride-Induced Stress Corrosion Cracking of Austenitic Stainless Steel and Maintenance of Dry Cask Storage System Canisters" (ADAMS Accession No. ML12319A440), cracking of 300 series stainless steel may occur in environments consisting of moist air and chloride containing surface deposits at temperatures less than 140 degrees F.

6. Due to the age of some of the tanks under consideration, differences in the "as designed" and "as built" tank may exist. An understanding of the existence and extent of these differences may be significant in determining the susceptibility of the tank to degradation.

7. The interaction of aluminum and moist concrete may play a role in the long term performance of aluminum components.

In summary, recent events have indicated that RWSTs may undergo degradation which may lead to disruption of plant operations and could result in release of tritium to the environment. These events to date have been attributed to a variety of causes and have resulted in leakage issues, but have not challenged the structural integrity of the tanks. Licensees are encouraged to consider a wide range of environmental and mechanical degradation modes for these tanks when developing or revising inspection or aging management programs.

CONTACTS

This IN requires no specific action or written response. Please direct any questions about this matter to the technical contact listed below or the appropriate project managers in the Office of Nuclear Reactor Regulation (NRR) and Office of New Reactors (NRO).

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Note: NRC generic communications may be found on the NRC public Web site, http://www.nrc.gov, under the NRC Library.

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