UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

May 25, 2011

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL APPLICATION FOR THE SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2

During the 583rd meeting of the Advisory Committee on Reactor Safeguards (ACRS), May 12-14, 2011, we completed our review of the license renewal application for the Salem Nuclear Generating Station, Units 1 and 2, and the final Safety Evaluation Report (SER) prepared by the NRC staff. Our Plant License Renewal Subcommittee also reviewed this matter during its meeting on December 1, 2010. During these reviews, we had the benefit of discussions with representatives of the NRC staff and the applicant, PSEG Nuclear LLC. We also had the benefit of the documents referenced. This report fulfills the requirement of 10 CFR 54.25 that the ACRS review and report on all license renewal applications.

CONCLUSION AND RECOMMENDATION

1. The programs established and committed to by the applicant to manage age-related degradation provide reasonable assurance that Salem Nuclear Generating Station, Units 1 and 2, can be operated in accordance with their current licensing bases (CLB) for the period of extended operation without undue risk to the health and safety of the public.

2. The application for renewal of the operating licenses of Salem Nuclear Generating Station, Units 1 and 2, should be approved.

BACKGROUND AND DISCUSSION

Salem Nuclear Generating Station contains two Westinghouse pressurized water reactor units with large dry containments. The site is located approximately 40 miles southwest of Philadelphia, Pennsylvania, and approximately 8 miles from Salem, New Jersey. Hope Creek Generating Station is also located at the same site.

Operation of Salem Unit 1 was initially restricted to a licensed power of 3338 MWt until 1986, when the power level was increased to the design power rating of 3411 MWt. The original licensed power rating for Unit 2 was 3411 MWt. The current licensed power of each unit is 3459 MWt, which includes 1.4 percent power uprates that were implemented in 2001. The Salem Unit 1 steam generators were replaced in 1998, and the Unit 2 steam generators were replaced in 2008. The Salem Unit 1 and Unit 2 reactor vessel heads were replaced in 2005.

In August 2009, PSEG Nuclear LLC requested renewal of the Salem operating licenses for 20 years beyond the current license terms, which expire on August 13, 2016, for Unit 1 and April 18, 2020, for Unit 2.

In the final SER, the staff documented its review of the license renewal application and other information submitted by the applicant or obtained during two staff audits and one inspection conducted at the plant site. The staff reviewed the completeness of the applicant's identification of structures, systems, and components (SSCs) that are within the scope of license renewal; the integrated plant assessment process; the applicant's identification of the plausible aging mechanisms associated with passive, long-lived components; the adequacy of the applicant's aging management programs (AMPs); and the identification and assessment of time-limited aging analyses (TLAAs) requiring review.

The applicant identified the SSCs that fall within the scope of license renewal and performed an aging management review for these SSCs. The applicant will implement 48 AMPs for license renewal. These include 32 existing programs and 16 new programs. A total of 42 AMPs, 10 of which contain enhancements, are consistent with the guidance in the Generic Aging Lessons Learned (GALL) Report. Eight AMPs contain one or more exceptions to approaches specified in the GALL Report. Six plant-specific programs manage issues that are either not addressed or are not consistent with guidance in the GALL Report. These include three existing programs for inspections of buried non-steel piping, periodic inspections and testing of boral neutron-absorbing material in the spent fuel racks, and management of cracking in nickel alloy components in the reactor coolant system. Three new plant-specific programs include periodic inspections of high voltage insulators; periodic inspections of piping, ducts, tanks, and heat exchangers; and periodic inspections of above-ground non-steel tanks. We reviewed the plant-specific programs and the AMP exceptions to the GALL Report, and we agree with the staff that they are acceptable.

The applicant identified the systems and components requiring TLAAs and reevaluated them for the period of extended operation. The staff concluded that the applicant has provided an acceptable list of TLAAs, as defined in 10 CFR 54.3. Furthermore, the staff concluded that in all cases the applicant has met the requirements of the License Renewal Rule by demonstrating that the TLAAs will remain valid for the period of extended operation, or the TLAAs have been projected to the end of the period of extended operation, or the aging effects will be adequately managed for the period of extended operation. We concur with the staff's conclusion that the TLAAs have been properly identified and that the required criteria will be met for the period of extended operation.

The staff conducted two license renewal audits and one inspection at the Salem site. The audits verified the appropriateness of the aging management scoping and screening methodology, and AMP consistency with guidance in the GALL Report. The inspection examined the scoping and screening of SSCs that are not safety related and verified the adequacy of the guidance, documentation, and implementation of selected AMPs. The audit and inspection teams also performed independent searches of the Salem condition report databases to confirm that plant-specific operating experience has been adequately addressed during the AMP development and implementation processes. Based on the audits and inspections, the staff concluded in the final SER that the proposed activities will adequately manage the aging of SSCs identified in the application and that the intended functions of these SSCs will be maintained during the period of extended operation. We agree with these conclusions.

The AMP for Inaccessible Medium Voltage Cables Not Subject To 10 CFR 50.49 Environmental Qualification Requirements will be used to manage the aging effects and mechanisms of non-environmentally qualified, in-scope, inaccessible, medium voltage (i.e., 4.16kV and 13.8kV) cables. No low voltage cables are in-scope for this program. The program is consistent with the guidance in Revision 2 of the GALL Report.

Cable test frequencies will be established based on the test results and industry operating experience. The maximum time between tests will be six years. Prior to the period of extended operation, the frequency of inspections for accumulated water will be established based on inspection results to minimize the exposure of medium voltage cables to significant moisture. The maximum time between inspections will be one year.

Salem Units 1 and 2 have not experienced any cracking of ASME Class 1 small bore piping. The AMP for One-Time Inspection of ASME Code Class 1 Small-Bore Piping includes external visual examinations, two volumetric examinations from a population of 36 susceptible small bore socket welds on Unit 1, and two volumetric examinations from a population of 34 susceptible welds on Unit 2. These commitments are consistent with the guidance in Revision 2 of the GALL Report. We concur with the staff's conclusion that this program, which accounts for the Salem plant-specific operating experience, will adequately monitor and manage the effects of aging in these welds.

Salem Units 1 and 2 do not have any in-scope buried tanks. None of the in-scope buried piping has cathodic protection. Inspections conducted during the existing Buried Piping and Tanks Inspection Program have identified missing protective wrapping on a leaking welded joint in out-of-scope fuel oil piping and missing protective coating for in-scope auxiliary feedwater piping at Unit 1. No similar conditions have been identified during inspections at Unit 2. Although the Unit 1 auxiliary feedwater piping had a reduction in wall thickness, there have been no age-related, through-wall, piping failures in the plant operating experience.

The enhanced Buried Piping and Tanks Inspection Program will contain guidance and methods consistent with current industry initiatives for the management of buried piping integrity. Salem inspection priorities will be derived from a composite corrosion risk ranking process that accounts for the safety significance, corrosion susceptibility, and radioactive fluid content of each in-scope piping system. Prior to the period of extended operation and every 10 years thereafter, the applicant will conduct inspections of excavated buried piping sections:

- A total of four sections of carbon steel piping selected from the auxiliary feedwater, service water, fire protection, circulating water, demineralized water, non-radioactive drains, and compressed air systems
- One section of gray cast iron fire protection piping
- One section of ductile cast iron fire protection piping
- One section of pre-stressed concrete piping selected from the service water and circulating water systems
- One section of stainless steel fuel transfer tube piping

The staff concluded that the proposed program will adequately monitor and manage the aging of buried piping. We agree with this conclusion.

Several instances of corrosion of the Salem Units 1 and 2 containment liners and the presence of borated water leakage in containment have been observed over the past 15 years. During the Salem Unit 2 outage in the fall of 2009, a very small leak of borated water was observed at the fuel transfer canal telltale. Borated water was observed on the containment liner plate moisture barrier under the fuel transfer canal. These leaks were attributed to reactor cavity leakage.

The containment liners are covered with insulation panels to a height of approximately 32 feet above the containment concrete floor. In consideration of industry operating experience with liner corrosion in the area near the floor joint and moisture barrier, the applicant removed the bottom portions of the insulation and inspected the inaccessible area. Liner corrosion was observed in the 3-inch region above the moisture barrier and below the bottom of the lowest leak chase channel. No corrosion was observed in the area below the moisture barrier or above the leak chase channel. The liner corrosion depth was measured, determined to be acceptable, and the liner surface was cleaned and recoated. The Salem Unit 1 and Unit 2 moisture barriers have been repaired or replaced. Prior to the period of extended operation, the applicant will remove 57 additional randomly selected insulation panels on each unit and inspect the condition of the containment liner behind each panel. Every three years during the period of extended operation, one insulation panel will be removed at random in each quadrant, and the liner will be inspected.

In addition, augmented inspections will be performed in the area of the containment liners under the fuel transfer canal and behind the insulation that are subject to possible leaks from the reactor cavity. These inspections will be performed on a frequency of once per Containment Inservice Inspection Period, starting with the current period. These augmented inspections will continue, under the IWE program, as long as leakage from the reactor cavity or fuel transfer canal is observed between the containment liner and the insulation.

The staff has concluded that these sampling and inspection programs will provide adequate monitoring and management of containment liner corrosion in the inaccessible locations. We agree with this conclusion.

Leakage from the Salem Unit 2 spent fuel pool (SFP) is currently approximately one gallon per day, as measured from its telltale drains. Leakage from the Unit 1 SFP is much larger. The measured leakage rate has been stable at approximately 100 gallons per day for the last seven years. The applicant has concluded that the Unit 1 leakage is through numerous small cracks in the welds in the fuel pool liner that are too small to be readily identified, located, and repaired. While no commitments have been made, the applicant indicated that efforts will continue to identify and, if possible, repair fuel pool liner cracks.

Prior to 2003, blockages in the leakage collection system piping allowed water leaking from the SFP to enter seismic construction gaps between the fuel building, auxiliary building, and containment. The escaping water created a tritium plume that extends in the soil southwest from the Unit 1 fuel building and containment, within the site boundary.

In 2003, the applicant implemented a leakage management program to control and capture the leaking water. The program ensures that the fuel pool telltale drains remain open, thus the leakage can be collected in a sump. A drain was also installed in the seismic gap to route water from that pathway into a collection vessel in the auxiliary building. Measurements show that

these actions have reduced flow into the surrounding soils, and tritium levels have trended downward. Remediation work has reduced the tritium concentrations in the plume.

The applicant will continue the Unit 1 fuel pool leakage management programs through the period of extended operation. The chemistry of the water from the drains will be monitored to assess any change that could indicate unexpected degradation of the concrete and rebar. Readings outside the expected range would require further investigation and evaluation.

Exposure to borated water could lead to dissolution of cementitious materials and weakening of the concrete. The water could also potentially corrode and weaken the rebar. However, examination of concrete cores from the Connecticut Yankee SFP and additional laboratory tests performed on concrete specimens for the applicant indicate that the structural capacity will not be significantly affected. The Structures Monitoring Program includes the reinforced concrete trench that collects the borated water drainage from the SFP telltale drains. Monitoring the condition of this trench provides an indication of the degradation in inaccessible areas and helps provide assurance that degradation of inaccessible structures will be detected before a loss of an intended function. The sump room wall will be inspected in accordance with ACI 349.3R every 18 months during the period of extended operation.

The applicant will also take core samples in each of the Unit 1 SFP walls (east and west) that have shown ingress of borated water through the concrete. The rebar exposed during sampling will be examined for signs of corrosion. The staff has concluded that these measures are sufficient to demonstrate that the effects of aging will be adequately managed so that the intended function(s) of the SFP structure will be maintained consistent with the CLB for the period of extended operation. We agree with this conclusion.

We agree with the staff that there are no issues related to the matters described in 10 CFR 54.29(a)(1) and (a)(2) that preclude renewal of the operating licenses for Salem Nuclear Generating Station, Units 1 and 2. The programs established and committed to by the applicant provide reasonable assurance that Salem Nuclear Generating Station, Units 1 and 2, can be operated in accordance with their current licensing bases for the period of extended operation without undue risk to the health and safety of the public. The PSEG Nuclear LLC application for renewal of the operating licenses for Salem Nuclear Generating Station, Units 1 and 2, should be approved.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

References:

1. U.S. Nuclear Regulatory Commission, NUREG-1944, "Safety Evaluation Report Related to the License Renewal of Salem Nuclear Generating Station," 04/27/2011 (ML111170317)

2. Letter to U.S. Nuclear Regulatory Commission, "Application for Renewed Operating Licenses – Salem Nuclear Generating Station, Unit No. 1 and Unit No. 2," 08/18/2009 (ML092430230)

3. Letter to Thomas Joyce, "Scoping and Screening Audit Summary Regarding the Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application (TAC NOS. ME1834 and ME1836)," 08/25/2010 (ML102280211)

4. Letter to Thomas P. Joyce, "Salem Nuclear Generating Station Units 1 and 2, and Hope Creek Generating Station – NRC License Renewal Inspection Report 05000272/2010010, 05000311/2010010, 05000354/2010010," 10/01/2010 (ML102740350)

5. Letter to Thomas P. Joyce, "Salem Nuclear Generating Station Units 1 and 2, and Hope Creek Generating Station – NRC License Renewal Inspection Report Nos. 05000272/2010006, 05000311/2010006, 05000354/2010006," 10/14/2010 (ML102871030)

6. Letter to Thomas Joyce, "Audit Report Regarding the Salem Nuclear Generating Station, Units 1 and 2, License Renewal Application (TAC NOS. ME1834 and ME1836)," 11/09/2010 (ML102430586)

7. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report With Open Items Related to the License Renewal of Salem Nuclear Generating Station," 11/2010 (ML103120172)

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Sincerely,
/RA/
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Chairman

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Letter to the Honorable Gregory B Jaczko, Chairman, NRC, from Said Abdel-Khalik, Chairman, ACRS, dated May 25, 2011

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL APPLICATION FOR THE SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2

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