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U.S. Nuclear Regulatory Commission
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Salem Nuclear Generating Station, Unit No. 1 and Unit No. 2
Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: Response to NRC Request for Additional Information, dated August 3, 2010, related to the ASME Section XI, Subsection IWE Program and Structures associated with the Salem Nuclear Generating Station, Units 1 and 2 License Renewal Application

Reference: Letter from Ms. Bennett Brady (USNRC) to Mr. Thomas Joyce (PSEG Nuclear, LLC) "REQUEST FOR ADDITIONAL INFORMATION REGARDING ASME SECTION XI, SUBSECTION IWE FOR THE SALEM NUCLEAR GENERATING STATION UNITS 1 AND 2 LICENSE RENEWAL APPLICATION (TAC NOS. ME1834 AND ME1836)", dated August 3, 2010

In the referenced letter, the NRC requested additional information regarding the ASME Section XI, Subsection IWE Program and Structures associated with the Salem Nuclear Generating Station, Units 1 and 2 License Renewal Application (LRA). Enclosure A contains the responses to this request for additional information. Included in these responses are updates to the Salem LRA Sections (i.e., LRA Appendix A and B Program Descriptions) affected by the RAI responses.

Enclosure B provides an update to the affected portions of the License Renewal Commitment List (LRA Appendix A, Section A.5), as a result of these RAI responses. There are no other regulatory commitments contained in this submittal.

If you have any questions, please contact Mr. Ali Fakhar, PSEG Manager - License Renewal, at 856-339-1646.

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I declare under penalty of perjury that the foregoing is true and correct.

Executed on 9/1/10

Sincerely,

Robert C. Braun
Senior Vice President, Operations
PSEG Nuclear LLC

Enclosures: A. Response to Request for Additional Information regarding IWE and Structures
B. License Renewal Commitment List (LRA Section A.5) Update

cc: Regional Administrator – USNRC Region I
B. Brady, Project Manager, License Renewal – USNRC
R. Ennis, Project Manager - USNRC
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Enclosure A

Response to Request for Additional Information regarding the ASME Section XI, Subsection IWE Program and Structures associated with the Salem Nuclear Generating Station, Units 1 and 2 License Renewal Application

RAI B.2.1.28-03
Follow-up RAI B.2.1.28-04
RAI B.2.1.33-05
Follow-up RAI B.2.1.33-06

Note: For clarity, portions of the original LRA text are repeated in this Enclosure. Added text is shown in ***Bold Italics***, and deletions are shown with strikethrough text.

RAI B.2.1.28-03

Background:

In response to RAI B.2.1.28-1, PSEG committed to perform additional corrective actions and augmented inspections for the Unit 1 and 2 containment liners and moisture barriers before the period of extended operation.

Issue:

The most recent IWE inspections of the Unit 1 and Unit 2 containment liners were performed in the spring of 2010 and fall of 2009, respectively. These inspections identified the need for augmented inspections and other corrective actions in accordance with requirements in ASME Section XI Subsection IWE. IWE-2420 requires that augmented inspections be completed during the next inspection period. The period of extended operation for Salem Units 1 and 2 will commence in August 2016 and April 2020, respectively. The staff is concerned that delays in completing the augmented inspections and corrective actions until prior to the start of the period of extended operation may affect the leak tightness of the containment liner.

Request:

The applicant is requested to provide a detailed schedule for performing corrective actions and augmented inspections for the Unit 1 and 2 containment liners that comply with requirements in ASME Section XI Subsection IWE.

PSEG Response:

The examinations of the Salem Unit 1 and Salem Unit 2 containment liners, conducted in 2009 and 2010, comply with the requirements of the 1998 Edition of ASME Section XI, Subsection IWE and 10CFR50.55a. The examination results, which identified degradation, were entered into the Corrective Action Program, and evaluated or repaired to ensure containment integrity. The examination results and corrective actions are described in detail in the response to RAI B.2.1.28-1 (PSEG letter to the NRC, LR-N10-0165, dated May 13, 2010). The following paragraphs provide more detail regarding the implementation schedule for the future corrective actions.

The entire Salem Unit 1 Containment liner area at the floor junction has been examined, evaluated, cleaned and painted, and the moisture barrier replaced at the floor and knuckle plate area, during the spring of 2010 refueling outage. No degradation of the liner below the moisture barrier was evident. The corrective actions requiring Containment liner insulation removal, in areas where the potential for Containment liner corrosion is suspected, will be continued during the next refueling outage (hereinafter referred to as outage) , in the fall of 2011. The corrective actions requiring Containment liner insulation removal may not be completed if there is corrosion discovered that leads to an expanded inspection area. Therefore, the removal of the insulation panels may be completed over the next few outages, if limited corrosion is found in small areas that does not compromise the liner plate thickness margin. If sufficient liner margin is not assured, any additional inspections and any corrective actions will be expedited in accordance with IWE requirements. In any event, the corrective actions, involving insulation removal in areas where the potential for Containment liner corrosion is suspected, will be completed prior to the Period of Extended Operation (PEO).

The Salem Unit 2 Containment liner area at the floor junction will be examined, evaluated, cleaned and painted, and the moisture barrier repaired at the floor and knuckle plate area next outage, in the spring of 2011. Degradation of the liner below the moisture barrier will also be investigated next outage. The corrective actions will start during the next outage but may not be completed during that outage, as described below. Examinations of the 1/4" liner below the floor may extend to additional outages depending upon what is discovered. The removal of the Containment liner insulation panels, in areas where the potential for Containment liner corrosion is suspected, may take a few outages. The corrective actions requiring insulation removal, in areas where the potential for Containment liner corrosion is suspected, will start during the next outage but may not be completed if there is corrosion found that leads to an expanded inspection area, requiring adjacent insulation panels to be removed. Therefore, the removal of the insulation panels may be completed over the next few outages, if limited corrosion is found in small areas that does not compromise the liner plate thickness margin. If sufficient liner margin is not assured, any additional inspections and any corrective actions will be expedited in accordance with IWE requirements. In any event, the corrective actions, described above, will be completed prior to the Period of Extended Operation (PEO).

Initial augmented inspections have begun and will be completed during the subsequent inspection Period immediately following the initial discovery. Since a new 10 year, Containment Inservice Inspection (CISI) Interval commenced for both Salem Unit 1 and Unit 2 in 2010, the augmented inspections will be completed within the next three year Period. As a result, the augmented inspections will be completed for both Salem Unit 1 and Salem Unit 2 within the next two outages, which will be by 2013. Depending upon the results of the augmented inspections, additional augmented inspections will be performed, as required by IWE, in the same or in subsequent CISI Periods and refueling outages.

There will be no delays in completing the augmented inspections and corrective actions prior to the start of the period of extended operation. The schedule for performing corrective actions and augmented inspections for the Salem Unit 1 and Salem Unit 2 Containment liners complies with requirements in ASME Section XI Subsection IWE and 10CFR50.55a. The response to RAI B.2.1.28-1 was intended to reflect the scope of the ASME Section XI, Subsection IWE aging management program (Salem LRA Appendix B, Section B.2.1.28) and not meant to change compliance with IWE scheduling requirements.

Follow-up RAI B.2.1.28-04

Background:

In response to RAI B.2.1.28-2, PSEG committed to perform examinations of inaccessible areas of the Unit 1 and 2 containment liners at 57 randomly selected insulation panels, in each unit, before the period of extended operation to detect evidence of loss of material. In addition, a total of 12 containment liner insulation panels will be selected, in each unit, during each ten-year inspection interval of the period of extended operation, to monitor the condition of the containment liner plates behind the liner insulation panels.

Issue:

The most recent IWE inspections of the Unit 1 and Unit 2 containment liners were performed in the spring of 2010 and fall of 2009, respectively. These inspections identified the need for inspecting inaccessible portions of the containment liners located behind the insulation panels because corrosion was detected in some liner plate sections located behind the insulation. The period of extended operation for Salem Units 1 and 2 will commence in August 2016 and April 2020, respectively. Therefore, the staff is concerned that corrosion in the inaccessible portions of the liners could remain undetected until the period of extended operation. This delay in inspection of liner plates located behind the randomly selected insulation panels may affect the leak tightness of the containment liners. By the requirements of 10 CFR 54.3 the effects of aging on the functionality of in-scope structures such as the containment liner must be managed to maintain the current licensing basis (CLB) during the period of extended operation. In addition, the RAI response does not clearly identify the time gap between inspections of liner plates located behind 57 randomly selected insulation panels and the subsequent inspections of liner plates located behind the 12 insulation panels.

Request:

The applicant is requested to provide the following:

1. Schedule for performing liner plate inspections at 57 randomly selected locations and augmented inspections for Unit 1 and 2 containment liners that comply with requirements in ASME Section XI Subsection IWE and 10 CFR 54.3.

2. The time gap between inspections of liner plates at 57 randomly selected insulation panels and subsequent inspections at 12 insulation panels.

PSEG Response:

1. The schedule for performing augmented inspections for Unit 1 and Unit 2 Containment liner plates is addressed in the RAI B.2.1.28-03 response provided above. This includes the corrective actions requiring Containment liner insulation removal, in areas where the potential for Containment liner corrosion is suspected and any required subsequent

inspections depending upon the conditions discovered. The schedule for performing the augmented inspections complies with the requirements in ASME Section XI, Subsection IWE.

The liner plate examinations at 57 randomly selected locations, previously addressed in RAI B.2.1.28-2 (PSEG letter to the NRC, LR-N10-0165, dated May 13, 2010), are planned to be implemented by August 2016 for both Salem units. It has not yet been finalized whether these liner plate examinations will be scheduled during a single or multiple outages. If the liner plate examinations are scheduled over multiple outages, the number of locations of random liner plate examinations will be approximately equal for each outage. The current plan is to schedule the 57 random liner examinations during earlier available outages and not schedule all of the 57 random liner examinations during the last possible outage prior to August of 2016. The current plans for Salem Unit 1 involve utilizing the following outages: Spring 2013, Fall 2014, and Spring 2016. The current plans for Salem Unit 2 involve utilizing the following outages: Fall 2012, Spring 2014, and Fall 2015.

Any corrosion observed during the Containment liner examinations is addressed per the IWE requirements.

The liner plate examinations behind the 57 randomly selected locations will not duplicate the locations of Containment liner insulation panels previously removed for other Containment liner examinations. This is a clarification to the LRA Enhancement #1 described in the response to RAI B.2.1.28-2 to the ASME Section XI, Subsection IWE aging management program (Salem LRA Appendix B, Section B.2.1.28).

2. The time gap between completion of examinations of liner plates behind the 57 randomly selected Containment liner insulation panels and the subsequent examinations at 12 Containment liner insulation panels will be the years between the completion of the 57 randomly selected insulation panels prior to PEO and the beginning of the first Containment Inservice Inspection (CISI) Period during PEO. The Containment liner examinations behind the 57 randomly selected insulation panels are planned to be completed prior to August 2016 for both Salem Unit 1 and Salem Unit 2.

   During the PEO, a reduced sample size of (4) insulation panels will be randomly selected and the liner examined during each CISI Period. The Containment liner behind a total of 12 insulation panels will be examined during each CISI Interval.

   In addition to the examinations behind the randomly selected Containment liner insulation panels, the IWE required inspections will address the potential for corrosion behind the Containment liner insulation panels, based upon conditions discovered in adjacent accessible areas. The IWE required Containment liner inspections are performed during all CISI Periods in accordance with IWE examination scheduling requirements.

The Appendix A and B revisions for the ASME Section XI, Subsection IWE aging management program, affected by this RAI response, are presented together as follows. Note that the LRA Appendix A, Section A.2.1.28 and Appendix B, Section B.2.1.28 shown below include the revisions due to the response to RAI B.2.1.28-2 submitted in PSEG letter to the NRC, LR-N10-0165, dated May 13, 2010. The change involves a new requirement that the randomly selected containment liner insulation panels will not include containment liner insulation panels previously removed to allow for inspection. Some pre-existing text is repeated here to provide context for the changes. The existing LRA text and revisions from the previous RAI are formatted in normal font; new text is bold and italicized.

Starting with the third paragraph, Section A.2.1.28 of the LRA is clarified as follows:

A.2.1.28 ASME Section XI, Subsection IWE

The ASME Section XI, Subsection IWE aging management program will be enhanced to include:

1. Inspection of a sample of the inaccessible liner covered by insulation and lagging prior to the period of extended operation and every 10 years thereafter. Should unacceptable degradation be found additional insulation will be removed as necessary to determine extent of condition in accordance with the corrective action process.

   Prior to the period of extended operation

   - The samples shall include 57 randomly selected containment liner insulation panels per unit.
   - ***The randomly selected containment liner insulation panels will not include containment liner insulation panels previously removed to allow for inspection.***
   - The examination will be performed by either removing the containment liner insulation panels and performing a visual inspection, or by using a pulsed eddy current (PEC) remote inspection, with the containment liner insulation left in place, to detect evidence of loss of material. If evidence of loss of material is detected using PEC, the containment liner insulation panel will be subsequently removed to allow for visual and UT examinations

Enhancement #1 on LRA page B-132 is clarified as follows:

B.2.1.28 ASME Section XI, Subsection IWE

1. Inspection of a sample of the inaccessible liner covered by insulation and lagging prior to the period of extended operation and every 10 years thereafter. Should unacceptable degradation be found additional insulation will be removed as necessary to determine extent of condition in accordance with the corrective action process. **Program Elements Affected: Scope of Program (Element 1)**

Prior to the period of extended operation

- The samples shall include 57 randomly selected containment liner insulation panels per unit.
- ***The randomly selected containment liner insulation panels will not include containment liner insulation panels previously removed to allow for inspection.***
- The examination will be performed by either removing the containment liner insulation panels and performing a visual inspection, or by using a pulsed eddy current (PEC) remote inspection, with the containment liner insulation left in place, to detect evidence of loss of material. If evidence of loss of material is detected using PEC, the containment liner insulation panel will be subsequently removed to allow for visual and UT examinations.

RAI B.2.1.33-05

Background:

In its response to RAI B.2.1.33-1, dated May 13, 2010, the applicant stated that:

1. The predicted depth of penetration of concrete after 70 years exposure to spent fuel pool (spf) water at 100°F is 1.30 inch. The applicant has analyzed the concrete structure assuming degradation of this layer; however, this assumes that borated water only migrates through the concrete along the construction joint.

2. Salem has also assessed the impact of potential degradation of the slab on the integrity of the SFP liner. The primary concern is that local degradation of the slab can create "voids" underneath the SFP liner. If a void corresponds to the location of a rack foot, the foot may no longer be supported on a firm surface. A scoping assessment included in MPR-2613 demonstrates that the liner is sufficiently ductile to accommodate the load from the fuel racks even if the foot of the rack is positioned over an area of local concrete degradation.

3. The applicant committed to perform a shallow core sample in the SFP wall where previous inspections have shown ingress of borated water through concrete. The core sample will be examined to assess degradation from the borated water.

Issue:

1. During the audit, the staff observed photographs of the fuel handling building (FHB) sump room which seem to indicate that borated water had penetrated to the outside surface of the SFP wall even above the construction joint, indicating leakage was migrating through the concrete in locations other than the construction joint.

2. The staff could not find any details of the scoping analysis in the MPR -2613. There is only a short one paragraph discussion in section 7.3 of the report.

3. The applicant has not provided details about when the core drill will be taken, or the tests that will be performed on the core.

Request:

The applicant is requested to provide the following:

1. Provide an assessment that addresses whether or not the predicted penetration depth of 1.30 inch includes any margin for uncertainties in the test or actual field conditions. In addition, identify and assess the structural impacts of water migrating through existing cracks in the concrete, other than the construction joint. With the possibility of leakage at locations other than the construction joint, discuss whether or not additional visual examinations (i.e. annual, 18 months, etc.) of concrete for cracks, spalls, and stains on

the exposed concrete surface due to rebar corrosion will be conducted to assure the concrete is not experiencing degradation.

2. Provide the depth and width of voids considered and a summary of the analysis results for the SFP liner.

3. Provide the timeline for performing the core drill, the size of the core, as well as the tests which will be performed on the core. In addition, provide any plans for performing additional core drills to track changes/degradation in concrete and rebar during the period of extended operation.

PSEG Response:

1. The response to the first request in this RAI is separated into two sections as follows: a) an assessment of the margin for uncertainties included in the predicted penetration depth of 1.30 inch into concrete, and; b) an assessment of the structural impacts of water migrating through existing cracks in the concrete, other than the construction joint, with a discussion of visual examinations.

   a. The RAI request is the following, "Provide an assessment that addresses whether or not the predicted penetration depth of 1.30 inch includes any margin for uncertainties in the test or actual field conditions."

   The predicted penetration depth of 1.30 inch includes margin for uncertainties in the test and bounds actual field conditions.

   The extrapolation is developed in MPR Calculation 0108-0301-jlh-3, "Projection of Concrete Corrosion Depth," Revision 1. A copy of the calculation is included in MPR-2634, "Boric Acid Attack of Concrete and Reinforcing Steel," Revision 2, which was made available for NRC review during their visit to MPR on June 8, 2010. The data are considered proprietary and cannot be divulged as part of this response. However, the basis for the correlation is described below in detail.

   - The curve fit is based on the data from the Long-Term Test Program, which started in April 2005 and continues to the present. The last specimen to be removed from the boric acid bath was removed at the 39-month mark, which was July 2008. The curve is based on a total of 220 data points from 11 concrete specimens. The depth of affected paste was measured at twenty points on each specimen during petrographic examination. All of the measurements were used to develop the extrapolation.

Exposure Time	No. of Specimens	Total No. of Data Points
1 month	2	40
2 months	2	40
3 months	2	40
6 months	2	40
9 months	2	40
39 months	1	20
Total	**11**	**220**

- A least squares fit of the data was determined using the log form of Ficks Law. The standard deviation of the constant was calculated for a line (log form of Ficks Law) with a known slope (1/2 per Ficks Law; i.e., the exponent on time in Ficks Law). The extrapolation uses the best fit plus two standard deviations.

- The extrapolation includes a temperature correction to account for the difference between the bath temperature and the typical pool temperature (based on records of pool temperatures over a 2-year period). The temperature correction was based on the Einstein-Stokes equation which relates diffusivity to temperature and viscosity. Data from tests run at elevated temperature (testing to study approaches to accelerate degradation that was conducted in 2004) were used to determine the temperature correction.

The tests were conducted in a manner which is conservative with respect to the actual conditions expected in the Fuel Handling Building (FHB). First, the boric acid bath was periodically refreshed to maintain acidic conditions. Second, the boric acid in the bath was continuously circulated using a pump to prevent establishment of concentration gradients that would reduce the rate of degradation. The conditions in the FHB are much less aggressive than the test conditions. The combination of small leakage rate and the large surface area of concrete suggest a very low refresh rate of the boric acid behind the liner. Further, as the boric acid solution migrates over the concrete to an open channel, the boric acid reacts with the cement, increasing the pH of the borated water solution, and depleting the boric acid.

The results of the above testing have been further supported by the evaluation of concrete core samples taken from the Connecticut Yankee (CY) Spent Fuel Pool during decommissioning of CY. Refer to Salem RAI B.2.1.33-1 (PSEG letter to the NRC, LR-

N10-0165, dated May 13, 2010) for additional information regarding the CY concrete core samples.

b. The RAI request is the following, "In addition, identify and assess the structural impacts of water migrating through existing cracks in the concrete, other than the construction joint. With the possibility of leakage at locations other than the construction joint, discuss whether or not additional visual examinations (i.e. annual, 18 months, etc.) of concrete for cracks, spalls, and stains on the exposed concrete surface due to rebar corrosion will be conducted to assure the concrete is not experiencing degradation."

The evaluation in MPR-2613, "Salem Generating Station, Fuel Handling Building-Evaluation of Degraded Condition", is not limited to the construction joint at the base of the pool. The discussions in Section 6.6.3, "Degradation from Migration through Construction Joints and Cracks", and Section 7.2, "Reinforcing Steel Degradation from Migration through Construction Joints and Cracks", address boric acid migration through construction joints and cracks without limitation to a specific joint or crack. There are no significant structural impacts of water migrating through existing cracks in the concrete, or other construction joints. No additional visual examinations of concrete for cracks, spalls, and stains on the exposed concrete surface due to rebar corrosion are needed beyond current commitments to assure that there is no loss of intended function.

Cracks provide a means for boric acid transport into concrete to depths greater than it would diffuse, potentially increasing the depth of degradation. This effect is primarily a concern for cracks that connect to the concrete surface wetted by boric acid. It is less of an issue for cracks that do not connect to the surface because the boric acid must diffuse through concrete to reach the crack. The structural implications of boric acid transport through cracks are evaluated below.

- Any concrete degradation associated with boric acid transport through the crack will be localized to the immediate vicinity of the crack, as previously described. Since structural margin is driven by the condition of the general area, not small localized areas, concrete degradation is not a structural concern.
- Boric acid migration through cracks can expose embedded reinforcing steel to boric acid. This potential degradation is addressed in MPR-2613, sections 6.6.3 and 7.2. The discussions therein conclude that structural adequacy of the embedded rebar is maintained even if the boric acid migration through the crack continued for 70 years.
- This potential degradation for reinforcing steel is also addressed in MPR-2613, section 8.2.3, which addresses the CY cores, which were also examined for reinforcing steel degradation. It was found that even though the upper portions of the cores were

degraded from boric acid attack, the reinforcing steel exhibited no corrosion from boric acid attack.

Corrosion of carbon steel is strongly dependent on dissolved oxygen levels. Oxygen levels behind the liner are expected to be very low because (1) diffusion or migration of air up the telltales will not replenish the oxygen levels, and (2) available oxygen will be consumed by interaction with the channels.

PSEG Nuclear previously committed to perform periodic structural inspections of the FHB in accordance with ACI 349.3R as part of closeout of the unresolved item (URI) with NRC Region I in 2007, as documented in PSEG letter to the NRC, LR-N07-0059 (ADAMS Accession No. ML071080125). This commitment has been included in the LRA, Structures Monitoring Program, Appendix A, Section A.2.1.33, and Appendix B, Section B.2.1.33, and the License Renewal Commitment List, LRA Appendix A, Section A.5, Number 33, item number 5.a.

A revision of the enhancements is added, per this RAI response, to the Salem LRA, Appendix B.2.1.33 (Structures Monitoring Program) to increase the inspection frequency to every 18 months for the wall in the sump room where previous inspections have shown ingress of borated water through the concrete. This is considered sufficient to ensure that the potential degradation of the FHB concrete, from SFP leakage, is identified and addressed prior to a loss of intended function. See the revised enhancements to the Structures Monitoring Program at the end of this RAI response.

2. For the evaluation of the SFP liner, a void depth of 3/8 inch is conservatively postulated. The local effects have been considered for a void under the SFP liner with a diameter of 24 inches. The results, of the analyses for the SFP liner for voids of this size, reveal that there is sufficient ductility in the SFP liner to prevent cracking of the SFP liner.

   Section 7.3 of MPR-2613 discusses the evaluation of the liner integrity for boric acid attack of the concrete slab under the liner. The discussion therein describes the concern, provides a bounding and conservative estimate of the depth of the "void" that may be created by the concrete degradation, and provides an overview of scoping calculations that demonstrated that there is no challenge to the liner. The discussion below is based upon Section 7.3 with additional details on the scoping calculations.

   Boric acid will attack the cement paste, weakening it and causing it to de-bond from the coarse and fine aggregate. As the degradation progresses, a consolidated layer of coarse and fine aggregate may be formed on top of the concrete as the cement in the top layer fully degrades. The products of the reaction between boric acid and the cement diffuse back through the concrete to the boric acid solution and are transported away. However, the aggregate will remain because (1) the coarse and fine aggregates do not react with boric acid and (2) the velocity of the boric acid solution migrating over the slab is too low to transport sand or rock. In essence, degradation of the slab may produce a small voided depth below the ¼-inch stainless steel liner, but above the sand and rubble layer. The water pressure and loading from the Spent Fuel racks will deform the liner into the void. The results, of the analyses for the SFP liner for voids of this size, reveal that there is sufficient ductility in the SFP liner to prevent cracking of the SFP liner.

Section 7.3 of MPR-2613 estimates the depth of the void to be 3/8-inch. As discussed therein, this value is based on the projected depth of affected cement paste (1.30 inches for 70 years of exposure to boric acid) and the volume fraction for the aggregates (71%). An estimated void depth of 3/8-inch is a maximum value; it includes the following conservatisms.

- The depth of affected cement paste (i.e., depth of concrete degradation) is based on the MPR testing for a boric acid bath, which was refreshed and continuously circulated, as compared to the conditions in the SFP, which are much more stagnant with minimal refreshing (low leakage rate compared to surface area). Further, the 1.30 inch projection assumes that exposure to boric acid initiated at the beginning of plant life.
- The void depth is calculated based on the combined volume fraction of the coarse and fine aggregates. This approach inherently assumes that the aggregate particles pack together with no spaces or gaps between particles. However, the fine cement particles fill the gaps between aggregate particles, resulting in the reduction in depth being less than the combined volume fraction of cement and water.

The scoping calculations for SFP liner integrity considered two basic scenarios: general degradation (over the entire concrete slab) and local degradation.

General Degradation

Overall, large area degradation is not a concern as the entire liner plate essentially settles more or less uniformly with the loss of the concrete underneath of the liner. This degradation is not expected to result in significant strains on the SFP liner material.

Local Degradation

Local degradation may take place if the loss of cement paste occurs only over a small area. This could be compared to a void. To estimate the potential effect of local degradation, several load cases were considered. These include water pressure and

Spent Fuel rack support loads, as discussed below over wide voids, as well as a potentially long and narrow void. The Spent Fuel rack support case, over a wide void, is considered to be the worst case.

- Water Pressure – In the case of only pool water pressure, the size of the void needs to be large enough to develop yielding in the SFP liner plate due to water pressure. This void is estimated to be approximately 24 inches in diameter. Once yielding occurs, the SFP liner plate deforms 3/8-inch to the aggregate base and then stops. This potential deflection is very small and results in a very small strain considering the ductility of the stainless steel liner plate as further described under the Spent Fuel rack support load case.
- Spent Fuel Rack Support – In this case, the void was conservatively postulated to expand until the liner plate and/or the spent fuel rack support baseplate yields. The rack baseplate is 12 inches square and 1-1/4 inch thick stainless steel. If the local degradation reaches the nominal edges of the baseplate, the baseplate is expected to yield and settle the maximum 3/8-inch to the aggregate. This is conservative as the local degradation will likely not have sharply defined edges that coincide with the baseplate dimensions. Bending was the potential failure mechanism considered, since the potential shear stresses are well below the yield stress. The center rack support post is 5.25 inches in diameter, so the plate will bend from outside diameter of the post to the edge of the base plate and the SFP liner will follow. Thus, the angle of the bend in the SFP liner plate at the void would be approximately 6 degrees. Based on the ductility of stainless steel, the SFP liner can easily be bent (one-time) upwards of 180 degrees without cracking. Therefore, the strains are small (<10%) and the SFP liner will not leak.
- Another case considered was a long region of relatively narrow degradation, such that the plate is bending along only one axis, instead of bending across two axes such as at the void scenario. This scenario is not considered likely. The Spent Fuel rack support case is considered to be the worst case with respect to SFP liner ductility. Furthermore, the same conclusions regarding the SFP liner bending failure mechanism being critical apply to this load case as well.

Salem has also assessed the impact of potential degradation of the slab on the integrity of the SFP liner. The scoping assessment demonstrates that the SFP liner is sufficiently ductile to accommodate the load from the Spent Fuel racks even if the foot of the Spent Fuel rack is positioned over an area of local concrete degradation.

3. The core sample will be at least 4 inches in diameter and approximately 2 feet deep. The core sample will be taken by the end of 2013. Reinforcing steel will also be exposed for examination. Concrete testing will consist of compressive testing and petrographic

examination to correspond with the examinations and tests performed during the chemistry testing used to establish a concrete and rebar degradation rate for concrete at Salem Unit 1 due to exposure to borated water.

There are no current plans to perform additional core drills to track changes/degradation in concrete or reinforcing steel during the PEO. The core sample is intended to confirm the results of the chemistry testing associated with boric acid migration through cracks in concrete and the examination of the CY cores. In addition, the concrete examinations performed in accordance with ACI 349.3R are judged to be sufficient to identify other concrete degradation prior to a loss of intended function. Examinations were performed in 2006 and in 2009 in accordance with ACI 349.3R requirements. During these examinations of the SFP wall, where previous inspections had shown ingress of borated water through concrete, the concrete conditions did not exceed the second tier criteria for acceptance after review. The examination in 2009 concluded that the size, shape, and location of conditions presented in the base-line documentation (the 2006 examination) have not changed in appearance and no additional indications of significance were discovered during the inspection. Therefore, it was concluded that the observed conditions were inactive and the second-tier acceptance criteria in ACI 349.3R were not exceeded. Presently, there are no indications of active leakage from the SFP through the SFP wall. In 2007, surface strength tests on this wall confirmed that there were no changes in compressive strength even in areas at the construction joint. Further, all the estimated strengths exceeded the values used in the analyses of the Fuel Handling Building. The results of the surface strength testing were provided as part of closeout of the unresolved item (URI) with NRC Region I in 2007, as documented in PSEG letter to the NRC, LR-N07-0059, dated March 30, 2007 (ADAMS Accession No. ML071080125). Therefore, plans for additional core drills will be developed only if required as a result of any unexpected adverse findings from the core bore testing and examination or as a result of the future concrete examinations performed in accordance with ACI 349.3R.

The Appendix A and B revisions for the Structures Monitoring Program, affected by this RAI response, are presented together as follows. Note that the LRA Appendix A, Section A.2.1.33 and Appendix B, Section B.2.1.33 shown below include the revisions due to the response to RAI B.2.1.33-1 submitted in PSEG letter to the NRC, LR-N10-0165, dated May 13, 2010. The revisions involve an increase in the frequency of the Salem Unit 1 SFP sump room wall inspection and a clarification that the core drill only applies to Salem Unit 1. Some pre-existing text is repeated here to provide context for the revisions. The existing LRA text and revisions from the previous RAI are formatted in normal font; new text is bold and italicized.

A new addition "e" to Enhancement #5 on LRA page A-27 is added as follows:

A.2.1.33 Structures Monitoring Program

5. Require the following actions related to the spent fuel pool liner:

    a. Perform periodic structural examination of the Fuel Handling Building per ACI 349.3R to ensure structural condition is in agreement with the analysis.

    b. Monitor telltale leakage and inspect the leak chase system to ensure no blockage.

    c. Test water drained from the seismic gap for boron, chloride, and sulfate concentrations; and pH.

    d. Perform a shallow core sample in the ***Unit 1*** Spent Fuel Pool wall where previous inspections have shown ingress of borated water through the concrete. The core sample will be examined for degradation from borated water.

    e. Perform a structural examination per ACI 349.3R every 18 months of the Unit 1 Spent Fuel Pool wall in the sump room where previous inspections have shown ingress of borated water through the concrete.

A new addition "e" to Enhancement #5 on LRA page B-153 is added as follows:

B.2.1.33 Structures Monitoring Program

5. Require the following actions related to the spent fuel pool liner:

    a. Perform periodic structural examination of the Fuel Handling Building per ACI 349.3R to ensure structural condition is in agreement with the analysis.

    b. Monitor telltale leakage and inspect the leak chase system to ensure no blockage.

c. Test water drained from the seismic gap for boron, chloride, and sulfate concentrations; and pH.

d. Perform a shallow core sample in the ***Unit 1*** Spent Fuel Pool wall where previous inspections have shown ingress of borated water through the concrete. The core sample will be examined for degradation from borated water.

e. Perform a structural examination per ACI 349.3R every 18 months of the Unit 1 Spent Fuel Pool wall in the sump room where previous inspections have shown ingress of borated water through the concrete.

Follow-up RAI B.2.1.33-06

Background:

In its response to RAI B.2.1.33-2, dated May 13, 2010, the applicant stated that: "Evidence of boric acid deposits on the Unit 2 containment liner under the fuel transfer canal has been observed during multiple outages since November 2000.

The leakage path is postulated to be through the reactor cavity and fuel transfer canal liner, then through concrete construction joints and cracks, and then down the sides of the containment liner behind the lagging inside containment.

This leakage has the potential to impact the containment liner. The impact of leakage on the containment liner is documented in Salem's response to RAI B.2.1.28-1."

Issue:

Salem's response to RAI B.2.1.28-1 includes onetime inspection results for randomly selected areas of inaccessible portions of the containment liners, and does not include any specific inspection requirements for the liner plate located in areas of postulated leakage. In addition, the response to RAI B.2.1.28-1 does not include any corrective actions for preventing borated water from flowing down the containment liner.

Request:

The applicant is requested to provide details of any corrective actions planned to prevent flow of borated water down the containment liner during the period of extended operation. In addition, provide plans for inspecting inaccessible portions of containment liners located in areas of postulated leakage.

PSEG Response:

There are currently no plans to prevent flow of borated water down the containment liner during the PEO since leakage behind the Containment liner insulation has been intermittent and when insulation panels were pulled to allow for liner inspection, the liner was in good condition even though some borated water had flowed behind the liner insulation.

Inaccessible portions of the Containment liner, which are behind insulation, are inspected after removal of insulation panels, if there is a reason to suspect that there may be corrosion behind the insulation based upon conditions found in accessible areas. Depending upon the results of the examination, augmented examinations will be performed as required by ASME Section XI, Subsection IWE.

A new enhancement is added, per this RAI response, to the ASME Section XI, Subsection IWE aging management program (Salem LRA, Appendix A, Section A.2.1.28, and Appendix B, Section B.2.1.28), to specifically include owner augmented inspections at Unit 1 and Unit 2 for the area of the containment liner, under the fuel transfer canal and behind the Containment liner insulation, which are subjected to leaks from the reactor cavity and fuel transfer canal. These examinations have previously been performed and these examinations are planned to be repeated prior to the end of the next CISI Period, which ends in 2013. These owner augmented inspections will be performed on a frequency of once per Containment Inservice Inspection Period. These owner augmented inspections will continue, under the IWE aging management program, as long as leakage from the reactor cavity or fuel transfer canal is observed between the Containment liner and the Containment liner insulation, including during the PEO.

The location(s) of the reactor cavity and fuel transfer canal leakage have not been determined. The cause(s) of the reactor cavity and fuel transfer canal leakage may be related to water temperature, or loads on the liner, all of which vary. The reactor cavity and fuel transfer canal leakage are also small and variations in flow have occurred, increasing the difficulty of determining the leakage source. It should be noted that the corrosion referred to in RAI B.2.1.28-1 (PSEG letter to the NRC, LR-N10-0165, dated May 13, 2010), which is referenced in the background of this RAI, was attributed to Service Water leaks, and not to borated water leaks.

The Appendix A and B revisions for the ASME Section XI, Subsection IWE aging management program, affected by this RAI response, are presented together as follows. The existing LRA text is formatted in normal font; new text is bold and italicized.

A new Enhancement #4 on LRA page A-23 is added as follows:

A.2.1.28 ASME Section XI, Subsection IWE

4. ***Owner augmented inspections will be performed at the Salem Unit 1 and Unit 2 area of the Containment liner, under the fuel transfer canal and behind the Containment liner insulation, which are subjected to leaks from the reactor cavity. These owner augmented inspections will be performed on a frequency of once per Containment Inservice Inspection Period, starting with the current Period. These owner 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 Containment liner insulation, including during the PEO.***

A new Enhancement #4 on LRA page B-132 is added as follows:

B.2.1.28 ASME Section XI, Subsection IWE

Enhancements

4. ***Owner augmented inspections will be performed at the Salem Unit 1 and Unit 2 area of the Containment liner, under the fuel transfer canal and behind the Containment liner insulation, which are subjected to leaks from the reactor cavity. These owner augmented inspections will be performed on a frequency of once per Containment Inservice Inspection Period, starting with the current Period. These owner 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 Containment liner insulation, including during the PEO. Program Elements Affected: Scope of Program (Element 1)***

Enclosure B

A.5 License Renewal Commitment List

The following table identifies revisions made to license renewal commitments 28 and 33 as a result of the RAIs contained in this package. Pre-existing text, from the LRA or previous RAI packages, is formatted in normal font; new text is bold and italicized; deleted text is indicated with strikethroughs. Pre-existing text has been repeated here to provide context for the changes. The specific RAIs that led to the commitment revisions are listed in the "SOURCE" column adjacent to the beginning of the new text. Any other actions described in this submittal represent intended or planned actions. The intended or planned actions are described for the information of the NRC and are not regulatory commitments.

NO.	PROGRAM OR TOPIC	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
28	ASME Section XI, Subsection IWE	ASME Section XI, Subsection IWE is an existing program that will be enhanced to include: 1. Inspection of a sample of the inaccessible liner covered by insulation and lagging once prior to the period of extended operation and every 10 years thereafter. Should unacceptable degradation be found additional insulation will be removed as necessary to determine extent of condition in accordance with the corrective action process. Prior to the period of extended operation • The samples shall include 57 randomly selected containment liner insulation panels per unit. • ***The randomly selected containment liner insulation panels will not include containment liner insulation panels previously removed to allow for inspection.***	A.2.1.28	Program to be enhanced prior to the period of extended operation. Inspection Schedule identified in Commitment	Section B.2.1.28 Salem letter LR-N10-0165 RAI B.2.1.28-2 ***Salem letter LR-N10-0321 RAI B.2.1.28-04***

		• The examination will be performed by either removing the containment liner insulation panels and performing a visual inspection, or by using a pulsed eddy current (PEC) remote inspection, with the containment liner insulation left in place, to detect evidence of loss of material. If evidence of loss of material is detected using PEC, the containment liner insulation panel will be subsequently removed to allow for visual and UT examinations 4. ***Owner augmented inspections will be performed at the Salem Unit 1 and Unit 2 area of the Containment liner, under the fuel transfer canal and behind the Containment liner insulation, which are subjected to leaks from the reactor cavity. These owner augmented inspections will be performed on a frequency of once per Containment Inservice Inspection Period, starting with the current Period. These owner 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 Containment liner insulation, including during the PEO.***			***Salem letter LR-N10-0321 RAI B.2.1.33-06***

NO.	PROGRAM OR TOPIC	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
33	Structures Monitoring Program	Structures Monitoring is an existing program that will be enhanced to include: 5. Require the following actions related to the spent fuel pool liner: a. Perform periodic structural examination of the Fuel Handling Building per ACI 349.3R to ensure structural condition is in agreement with the analysis. b. Monitor telltale leakage and inspect the leak chase system to ensure no blockage. c. Test water drained from the seismic gap for boron, chloride and sulfate concentrations; and pH. d. Perform a shallow core sample in the ***Unit 1*** Spent Fuel Pool wall where previous inspections have shown ingress of borated water through the concrete. The core sample will be examined for degradation from borated water. e. ***Perform a structural examination per ACI 349.3R every 18 months of the Unit 1 Spent Fuel Pool wall in the sump room where previous inspections have shown ingress of borated water through the concrete.***	A.2.1.33	Program to be enhanced prior to the period of extended operation.	Section B.2.1.33 Salem letter LR-N10-0165 RAI B.2.1.33-1 ***Salem letter LR-N10-0321 RAI B.2.1.33-05***