REQUESTS FOR ADDITIONAL INFORMATION FOR TURKEY POINT UNITS 3 AND 4 SUBSEQUENT LICENSE RENEWAL APPLICATION (SLRA) SECTION 3.5.2.2.2.6, "REDUCTION OF STRENGTH AND MECHANICAL PROPERTIES OF CONCRETE DUE TO IRRADIATION" AND AMP X.S1, "CONCRETE CONTAINMENT UNBONDED TENDON PRESTRESS"

REVISION 1, RAI SET 8

Section I – Fluence

Background

In SLRA Section 3.5.2.2.2.6, "Reduction of Strength and Mechanical Properties of Concrete Due to Irradiation," (Rev. 1) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18283A308), the applicant describes calculations performed to determine the projected peak neutron fluence and gamma dose within the PTN reactor cavity for 80 years of plant operation for downstream use in structural analysis calculations, which are used to demonstrate sufficient margin exists for the reactor vessel (RV) supports to carry various design basis loads; RAIs 3.5.2.2.2.6-1 through 3.5.2.2.2.6-3 below relate to these calculations. The applicant also describes calculations performed to estimate RV structural support steel irradiation damage to demonstrate that sufficient ductility exists in RV structural support steel to support the RV inlet and outlet nozzles; RAI 3.5.2.2.2.6-4 relates to these calculations.

Regulatory Basis

NUREG-2192, "Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants," (or SRP-SLR), Section 3.5.2.2.2.6, "Reduction of Strength and Mechanical Properties of Concrete Due to Irradiation," describes a method for determining whether the applicant has met the requirements of the NRC regulations in 10 CFR 54.21 by providing the acceptance criterion for the aging management of the reduction of strength and mechanical properties of concrete due to irradiation as it pertains to the reactor biological shield (or bioshield) wall. NUREG-2192 (SRP-SLR), Section 3.5.2.2.2.6 states:

> Reduction of strength, loss of mechanical properties, and cracking due to irradiation could occur in PWR and BWR Group 4 concrete structures that are exposed to high levels of neutron and gamma radiation. These structures include the reactor (primary/biological) shield wall, the sacrificial shield wall, and the reactor vessel support/pedestal structure. Data related to the effects and significance of neutron and gamma radiation on concrete mechanical and physical properties is limited, especially for conditions (dose, temperature, etc.) representative of light-water reactor (LWR) plants. However, based on literature review of existing research, radiation fluence limits of 1×10^{19} [neutrons per square centimeter (n/cm^2)] neutron radiation and 1×10^8 [Gray (Gy)] (1×10^{10} rad) gamma dose are considered conservative radiation exposure levels beyond which concrete material properties may begin to degrade markedly.
>
> Further evaluation is recommended of a plant-specific program to manage aging effects of irradiation if the estimated (calculated) fluence levels or irradiation dose received by any portion of the concrete from neutron (fluence cutoff [energy greater than 0.1 million-electron-volts [(E > 0.1 MeV)] or gamma radiation

> exceeds the respective threshold level during the subsequent period of extended operation or if plant-specific [operating experience] of concrete irradiation degradation exists that may impact intended functions. Higher fluence or dose levels may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and/or loss of mechanical properties of concrete from those fluence levels, at or above the operating temperature experienced by the concrete, and the effects are applied to the design calculations. Supporting calculations/analyses, test data, and other technical basis are provided to estimate and evaluate fluence levels and the plant-specific program. The acceptance criteria are described in BTP RLSB-1 (Appendix A.1 of this SRP-SLR).

Additionally, 10 CFR 54.21 requires SLR applicants to perform an integrated plant assessment. For PTN, the applicant has determined that this includes assessing the effects of irradiation damage resulting in a loss of fracture toughness of RV structural steel supports. Some of the RV structural steel support elements are partially embedded in the bioshield wall, but have exposed beams protruding from the bioshield wall including saddles that support the RV inlet and outlet nozzles.

RAI 3.5.2.2.2.6-1

<u>Additional Background</u>

The basis for SLRA Section 3.5.2.2.2.6 (Rev. 1) is documented in audit document FPLCORP020-REPT-130, Rev. 1, “Primary Shield Wall Irradiation Evaluation,” October 2018. As explained in audit document FPLCORP020-REPT-130, Rev. 1, Appendix G, “Radiation Analysis Support on Turkey Point Irradiated Concrete Exposures for Subsequent License Renewal Application,” on pgs. G-7 and G-10 of G-11, the peak fluence determined by the applicant is based on values reported by Westinghouse in audit document Westinghouse Letter FPL-09-41, “Turkey Point Units 3 and 4 - Extended Power Uprate (EPU),” Response to Shaw Request for Radiological Information, February 2009.

<u>Issue</u>

(1) The SLRA states that “calculations performed to determine the projected peak neutron fluence and gamma dose within the PTN Unit 3 and Unit 4 reactor cavity for 80 years of plant operation have shown that they are above the radiation exposure thresholds [stated in the SRP-SLR]…” However, these values used in the analysis are based on an azimuthally averaged value instead of the peak azimuthal value indicated in the SLRA.
(2) The SLRA states that “neutron fluence and gamma dose incident on the primary shield wall were determined as follows...” However, the fluence values in the audited documents are reported at a location 8 centimeters (cm) into the shield wall concrete instead of at the surface.

<u>Request</u>

Clarify the apparent discrepancies between the audit documents which use the azimuthally averaged value 8 cm into the shield wall concrete instead of the peak surface fluence value as stated in SLRA Section 3.5.2.2.2.6 (Rev. 1). Provide justification supporting the chosen approach.

RAI 3.5.2.2.2.6-2

Regulatory Guide 1.190, “Calculational and Dosimetry Methods for Determining Pressure Vessel Fluence,” Section 1.4, “Methodology Qualification and Uncertainty Estimates” (ADAMS No. ML010890301) is germane to reactor pressure vessel applications. However, it provides some general guidance useful for fluence method qualification.

Issue

In order to assess the methodology for determining fluence, the staff needs additional information that establishes the accuracy of the fluence estimates supporting SLRA Section 3.5.2.2.2.6.

Request

a. Validate the fluence methods chosen to estimate neutron and gamma fluence incident on and throughout the shield wall for the energy ranges of interest (i.e., E > 0.1 MeV for neutrons and for all gamma energies). Include comparisons with applicable measurement and calculational benchmarks or state why such is unnecessary. Include additional margin for uncertainty as appropriate if no applicable measurement or calculational benchmarks are available.

b. Quantify analytic uncertainty estimates for the reported fluence values of peak 80 year fluence, including all relevant sources of uncertainty, to demonstrate the accuracy of the methodology or provide a basis for not doing so.

RAI 3.5.2.2.2.6-3

Additional Background

SLRA Section 3.5.2.2.2.6 (Rev. 1) explains that the relative radial neutron fluence profile used to determine the relative neutron fluence throughout the PTN shield wall was based on the results in Figure 4-2, “Neutron flux (n/cm^{2}s – normalized per source neutrons) attenuation in Portland concrete (two-loop model),” of audit document EPRI Report 3002002676, “Expected Condition of Reactor Cavity Concrete After 80 Years of Radiation Exposure.”

Issue

It is not clear that the model used to generate the data in Figure 4-2 is relevant to PTN given that the audit document explains that the model used approximates an actual reactor geometry and spatial source distribution based on “an infinite two-dimensional (2-D) cylinder with a point source at the center with a typical U-235 fission spectrum.” It is not clear whether the applicant considered: (1) a detailed 3-D spatial source specification and (2) a fission spectrum specific to the more important and highly burned peripheral fuel assemblies, which are necessary to estimate an accurate fluence profile throughout the shield wall concrete due to the need to account for energy-dependent neutron transport pathways that originate at various points throughout the reactor rather than originating from a single point at the center of a geometrically simplified representation of the reactor. Furthermore, publicly available Ref. 6 cited in audit document EPRI 3002002676, simulating a more realistic reactor-shield wall configuration, indicates that the attenuation profile used by the applicant non-conservatively overestimates the actual attenuation. Justification for using that attenuation profile is not provided in the SLRA. The NRC staff notes that no comparisons were provided between the simplified model and more detailed models in the concrete region and takes exception to the following statement in

audit document EPRI Report 3002002676, which is based only on how the simplified model predicts attenuation throughout the reactor pressure vessel: “The variation between models was considered small enough that the [simplified] model can provide a reasonable spectrum for evaluation of attenuation in the concrete.”

Request

Justify use of the simplified model to determine the radial neutron fluence profile throughout the PTN shield wall.
Explain the basis for not using a concrete specific to PTN as this may have a significant impact on the concrete attenuation characteristics. Concrete characteristics include not only the concrete composition based on the Miami oolite concrete used at PTN, but the amount of concrete drying that has occurred with aging (e.g., due to elevated temperatures, migration of water away from the concrete surface inward, and drying due to any other environmental conditions).

RAI 3.5.2.2.2.6-4

Additional Background
The applicant provided its calculation for reactor vessel support displacements per atom (dpa) in audit document FPLCORP020-REPT-130, Rev. 1, Appendix E, “Irradiated Reactor Vessel Supports Evaluation,” pgs. E-5 and E-6 of E-9, which supports SLRA Section 3.5.2.2.2.6.

Issue

a. The audit document describes the dpa calculation. The reference cited for the calculation is from a textbook. Reviewing the textbook equations used: (1) the total integrated neutron flux term in Equation 12 of the textbook was not used, and (2) the average neutron energy term in Equation 13 of the textbook was not used (other values were used instead). It is not clear that the terms, as defined by the equations in the textbook being used as the reference defining the method by which the dpa is calculated, are being used.
b. The accuracy and precision of the model used to determine dpa is not clear because it has not been validated by comparison to an appropriate benchmark or standard (e.g., ASTM E693-17, “Standard Practice for Characterizing Neutron Exposures in Iron and Low Alloy Steels in Terms of Displacements per Atom (DPA)”) and no consideration of dpa uncertainty was considered.
c. SLRA Section 3.5.2.2.2.6 references a generic E > 1 MeV axial neutron flux profile corresponding to the neutron flux incident on a shield wall. The applicant explains that the profile shows that the flux at the top of active fuel region is 40% of the peak neutron flux at the top of the active fuel region. This 0.4 factor is combined with the PTN peak E > 0.1 MeV and E > 1 MeV neutron fluxes incident on the PTN shield wall and are used as inputs to the dpa rate calculation method.

Request

a. Provide justification for the method used, or correct the dpa rate calculation by:
   1. Using the total integrated neutron flux given by Equation 12 in the dpa rate calculation method reference.
   2. Using the average neutron energy as given by Equation 13 in the dpa rate calculation method reference.
b. Validate the dpa estimate by:

i. Comparing the dpa calculational model to an appropriate benchmark or standard and determining if application of a bias and/or uncertainty is warranted.

ii. Accounting for additional uncertainty in the dpa calculation due to:
1. Total fluence uncertainty affecting the total fluence term in Equation 11 of the dpa rate calculation method reference. Note: (1) that this request is related to RAI 3.5.2.2.2.6-2 and (2) any changes in the peak fluence due to the response to RAI 3.5.2.2.2.6-1 and/or RAI 3.5.2.2.2.6-3 may necessitate an update to the total fluence term used in Equation 11.
2. Fluence spectrum uncertainty affecting the average energy term (which is based on a weighting function equal to the fluence spectrum) in Equation 13 of the dpa rate calculation method reference.
3. Nuclear data uncertainty affecting the cross-section term in Equation 11 of the dpa rate calculation method reference.

c. Verify that the assumption of 0.4 for the axial peaking factor is bounding (or sufficiently representative) of past actual and future expected axial peaking factors corresponding to the most influential peripheral fuel assemblies with respect to neutron fluence incident on the shield wall at PTN for 80 years of operation.

Section II – Decrease in Fracture Toughness of RPV Supports

Background

In SLRA Section 3.5.2.2.2.6, "Reduction of Strength and Mechanical Properties of Concrete Due to Irradiation," (Rev. 1) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18283A308), the applicant describes evaluations performed to determine decrease in fracture toughness due to the effects of neutron irradiation on the reactor vessel structural steel supports. The applicant opted to follow the methodology in NUREG-1509 to assess the aging effects due to neutron embrittlement of the reactor vessel (RV) supports. RAIs 3.5.2.2.2.6-5 through 3.5.2.2.2.6-9 address the reduction in toughness of the steel RV supports.

Regulatory Basis

10 CFR 54.21 requires SLR applicants to perform an integrated plant assessment. For PTN, the applicant has determined that this includes assessing the effects of irradiation damage resulting in a loss of fracture toughness of RV structural steel supports. Some of the RV structural steel support elements are partially embedded in the concrete bioshield wall, but have exposed beams protruding from this wall, including saddles that support the RV inlet and outlet nozzles.

RAI 3.5.2.2.2.6-5

Issue

In the discussion of the bolting, SLRA Section 3.5.2.2.2.6 (Rev. 1) states:
Based on the review of NUREG-1509 and the design documentation of the PTN RV support bolting, no further evaluation for reduction in fracture toughness for the bolting is required.
However, the applicant did not articulate what information was used to reach that conclusion. The staff needs additional information to evaluate the adequacy of the applicant's assertion that no further evaluation is required per its citation of NUREG-1509.

Request

Describe in sufficient detail the analysis which led to the stated conclusion. Include descriptions of the specific information from NUREG-1509 and the applicable design documentation utilized in the analysis that provide the basis for the conclusions. This should include identification of the bolt material, neutron fluence at the location of the support bolting, estimation of the radiation embrittlement, and a description of the analyses following the flow charts in NUREG-1509, Figures 4-1, 4-2, 4-3, 4-4 and 4-5, as appropriate.

RAI 3.5.2.2.2.6-6

Additional Background

The analysis for ∆NDT in SLRA Section 3.5.2.2.2.6 (Rev. 1) uses the fitted curve from Figure 3-1 of NUREG-1509 citing:
The fitted curve was utilized because the test data points associated with the dpa being evaluated (in the 1 to 5 x 10^{-3} range) are all below the fitted data curve. Additionally, the upper-bound curve in the region of interest included points that combine neutron and gamma exposure and are based on only 2 worst case data points.

Issue

The trend curve in Figure 3-1 of NUREG-1509 was determined based on all of the data identified in Figure 3-1. Using the methodology of NUREG-1509, ∆NDT is determined using the bounding curve in Figure 3-1; the methodology does not include options for using the fitted curve, or restricting consideration of the data to a limited range of neutron fluence values. Section 4.4 ("Accurate Analysis") of NUREG-1509 states:

The initial NDT temperature of the RPV support material should be evaluated in accordance with the notes pertinent to Fig. 4-2. The radiation-induced ∆NDT should be estimated from the upper bound correlation curve from Fig. 3-1.

This is consistent with the example provided in Section 3.3 ("Trojan Dosimetry").

Request

Given the data and bounding curve fit in Figure 3-1, the basis for deviating from the methodology in NUREG-1509, using the fitted curve instead of the bounding curve, is not sufficient or clear. Provide a thorough technical basis for the use of the fitted curve, including appropriate consideration of the uncertainty in the estimate of ∆NDT.

RAI 3.5.2.2.2.6-7

Additional Background

The transition temperature analysis described in Figure 4-4 of NUREG-1509 features a step described in the flowchart box labeled "Evaluate TT_{EOL} + ***Margin*** ≤ LST", where TT_{EOL} is determined in the example cases based on the upper bound curve. Section 4.3.4.2 of NUREG-1509 states:

Uncertainties related to NDT determinations demand that a margin of safety be maintained between the LST and the NDT temperature, such as provided in Appendix R, Figure R-1200-1, Reference 18.

Issue

It is not clear how the margin component of the equation was considered or calculated for this step.

Request

Identify the appropriate margin that was used in the evaluation as addressed in NUREG-1509. Describe the analysis following the flowchart in Figure 4-4, particularly the flowchart box to determine “Evaluate TT_{EOL} + ***Margin*** ≤ LST” and the subsequent actions (following the flowchart in Fig. 4-4 of NUREG-1509) that may result.

RAI 3.5.2.2.2.6-8

Additional background

Section 4.3.1.1 of NUREG-1509 states:

Physical examination of the RPV supports is essential to the reevaluation. As mentioned previously, the purpose of the examination is to detect visible signs of degradation of the supports, including, but not limited to, rust, corrosion, cracks or permanent deformation of the members.

Figure 4-2 of NUREG-1509 identifies “evaluate existing physical condition” as one of the key inputs to the “preliminary evaluation” prior to performing the transition temperature approach described in Appendix E. The SLRA states that the visual inspections described in Appendix E “have not identified dimensional shifts or changes in the RV support steel,” but there is no mention of rust, corrosion or cracks as cited in NUREG-1509.

Issue

The SLRA does not describe the visual inspections described in Appendix E of NUREG-1509.

Request

Describe the examinations that have been performed to assess degradation of the RV supports due to rust, corrosion, and crack to provide a justifiable basis for the analysis.

RAI 3.5.2.2.2.6-9

As stated in the regulatory basis above, 10 CFR 54.21(1) states that an integrated plant assessment (IPA) must--For those systems, structures, and components within the scope of this part, as delineated in § 54.4, identify and list those structures and components subject to an aging management review (AMR).

Issue

The applicant did not address RPV supports in an irradiated environment in its AMR tables.

Request

For RPV supports in an irradiated environment, determine if an AMR item is required. If so, identify in the SLRA AMR items that address degradation of the RPV supports in the presence of a neutron environment, including plans for aging management. If not, justify how the requirements of 10 CFR 54.21 to perform an integrated plant assessment are being met.

Section III – RAIs for TRP 74 and TRP 43 AMR: Concrete (SLRA FE Section 3.5.2.2.2.6 Reduction of Strength and Mechanical Properties of Concrete Due to Irradiation)

RAI 3.5.2.2.2.6-11

Regulatory Basis

10 CFR 54.21(a)(3) requires the applicant to demonstrate that the effects of aging for structures and components will be adequately managed so that the intended function will be maintained consistent with the current licensing basis, for all structures and components (SCs) that have been scoped and screened-in for subsequent license renewal, for the subsequent period of extended operation. As described in SRP-SLR, an applicant may demonstrate compliance with 10 CFR 54.21(a)(3) by referencing the GALL-SLR Report and when evaluation of the matter in the GALL-SLR Report applies to the plant. SRP-SLR Section 1.2.1 notes that the SRP-SLR and GALL-SLR Reports do not provide a comprehensive list of all potential aging effects that may be applicable to structures subject to an Aging Management Review (AMR). Therefore, applicants should perform plant-specific AMRs for additional aging effects that are applicable. Branch Technical Position A.1.2, in Appendix A of the SRP-SLR, provides additional guidance on identifying applicable aging effects.

SRP-SLR Section 3.5.2.2.2.6 states that reduction of strength, loss of mechanical properties, and cracking due to irradiation could occur in PWR Group 4 concrete structures (e.g., reactor (primary/biological) shield wall, the sacrificial shield wall, and the reactor vessel support/pedestal structure) that are exposed to high levels of neutron and gamma radiation. The SRP-SLR recommends further evaluation of a plant-specific program to manage aging effects of irradiation if the estimated (calculated) fluence levels or irradiation dose received by any portion of the concrete (also referred to as reinforced/composite concrete) from neutron (fluence cutoff energy $E > 0.1$ MeV) or gamma radiation exceeds the SRP-SLR threshold levels during the subsequent period of extended operation or if plant-specific operating experience (OE) of concrete irradiation degradation exists that may impact intended functions.

Background

The SRP-SLR states that data related to the effects and significance of gamma radiation on concrete mechanical and physical properties is limited, especially for conditions (e.g., dose, temperature) representative of light-water reactor (LWR) plants. The SRP-SLR also states that based on literature review of existing research, a radiation limit of 1×10^8 Gy (1×10^{10} rad) gamma dose is considered a conservative radiation exposure level beyond which concrete material properties may begin to degrade markedly.

SLRA Section 3.5.2.2.2.6, as supplemented by letter dated October 5, 2018, states that Figure 7 of Hilsdorf (1978) paper “presented the change in compressive strength versus gamma dose for a limited amount of data.” The SLRA also states that “[t]he mean interpolated value of the trend of this data would indicate a decrease in compressive strength for a dose between 2.0 x 10^{10} rads to 3.0 x 10^{10} rads. However, the data that was used to derive the plot is varied and not considered as fully representative of commercial reactor conditions.” The SLRA further states the following:

> The Maruyama (2017) paper (Reference 1) suggested that either the threshold reference value for gamma exposure be raised to a high level or abandoned entirely. With consideration of the prior Hilsdorf data and the available test data presented by Maruyama, the test data indicates gamma irradiation up to and beyond a threshold of 2.3x10^{10} rads has no effect on material properties. Based on the above discussion, and considering the 80 year gamma dose incident on the primary shield wall at PTN is 1.9 x 10^{10} rads, there will be no degradation of the primary shield concrete at PTN due gamma radiation.

<u>Issue</u>

The staff noted that the SLRA references Maruyama’s (2017) study, which uses a gamma dose threshold of 2.3x10^{10} rads, as the basis to conclude that there will be no degradation of the PTN PSW concrete due to gamma radiation since PTN’s gamma dose is 1.9 x 10^{10} rads. It is not clear to the staff how Maruyama (2017) findings are a justified approach for screening out the effects of gamma radiation on PTN’s PSW concrete when the SRP-SLR threshold for damage is 1.0 x 10^{10} rads.

In its review of the referenced study, the staff noted the following:

- **<u>Gamma dose rate</u>:** the staff noted uncertainties on the applicability of test results relevant to gamma dose radiation of concrete in nuclear power plants (NPPs). For example, in Maruyama (2017) studies, concrete specimens were exposed to gamma ray dose rates 2-20 times greater (1.25 to 10 kGy/h) than expected at concrete components near a PWR reactor vessel (approx. 500 Gy/h). In that regard, Murayama’s paper (2017) states that “it is impossible, in principle, to determine whether the obtained data can be applied to commercial reactors without assessing the effects of dose-rate.” Also, in its conclusion summary of results for gamma-ray impact on concrete Maruyama (2017) states that “the findings reported in this work must be validated to ensure their reproducibility. […] After validation, the reference values for gamma rays should be abandoned.”

- **<u>Carbonation of concrete</u>:** Murayama’s paper (2017) notes that “[o]nly when concrete is carbonated under irradiation will its strength increase,” and that “[t]here was almost no difference between gamma ray-irradiated and heat dried specimens exposed to conditions under which carbonation typically proceeds,” noting the need for “[a]dditional gamma-ray irradiation tests on concrete without carbonation.” The paper then concludes that “[w]hen supplemental drying tests under non-CO_2 conditions were performed […] strength of those specimens quickly fell as the mass reduction rate increased, faster than the strengths of gamma-ray-irradiated and heat dried specimens.” It is not clear to staff whether the

applicant has taken into consideration the impact of carbonation, heating and drying on the results in Maruyama's paper (2017) and if and how that relates to the conditions on the concrete at PTN PSW concrete. Absent conditions suitable for carbonation of the concrete it is not clear how the applicant concludes that no loss of strength is expected due to gamma irradiation.

- **Temperature:** The staff also noted that the test temperature of the Maruyama study specimens was lower (10 to 30 degrees Celsius) than the operating temperature for the concrete at PTN's PSW (approximately 49 degrees Celsius). The staff notes that at higher temperatures more degradation due to irradiation is expected due to an increase in thermal stresses of concrete.

- **Cement type and w/c ratio:** The staff noted that PTN's concrete is composed of ASTM C-150-64 Florida Type II cement with a w/c ratio of 0.59, as reported in the SLRA and Supplement FPLCORP020-REPT-130, Revision 1, while Maruyama's gamma radiation tested concrete specimens used early high strength Type I cements with a much lower w/c ratio of 0.50. It is not clear if and how the gamma radiation induced aging effects (e.g.., radiolysis) of the Maruyama tested concrete specimens with a lower w/c ratio compare to the cast concrete of higher w/c ratio at PTN's PSW.

Based on both apparent dissimilarities between PTN concrete and that used in the Maruyama study and lack of consideration of some factors, it is not clear to staff if and how the Maruyama (2017) study test results for gamma dose aging effects on concrete are relatable and applicable to PTN PSW concrete. The staff needs additional information to justify the applicant's assumption that there are no aging effects on concrete due to interactions of gamma rays with cement paste and aggregate used in PTN concrete during the SPEO.

Request:
With regard to considerations such as the gamma dose rate, carbonation of concrete, aggregate, cement type, w/c ratio, and operating temperature of the concrete at PTN PSW versus the test specimens used in the Maruyama study: explain how the conclusions in Maruyama's paper can be used to assume that there is no degradation in material properties due to gamma dose, or provide justification for why such comparison between the PTN PSW and Maruyama study is unnecessary.

Section IV – RAIs Relevant to GALL-SLR AMP X.S1

Regulatory Background:

Title 10 of the Code of Federal Regulations (10 CFR) Section 54.21(a)(3) requires the applicant to demonstrate that the effects of aging for structures and components will be adequately managed so that the intended function will be maintained consistent with the current licensing basis for the period of extended operation. As described in SRP-SLR, an applicant may demonstrate compliance with 10 CFR 54.21(a)(3) by referencing the GALL-SLR Report and when evaluation of the matter in the GALL-SLR Report applies to the plant. SLRA Section

B.2.2.3 states that the applicant's Concrete Containment Unbonded Tendon Prestress program is an existing AMP that will be consistent with enhancements with the GALL-SLR Report AMP X.S1, "Concrete Containment Unbonded Tendon Prestress."

The GALL-SLR Report states:

> If an applicant credits an AMP in the GALL-SLR Report, it is incumbent on the applicant to ensure that the conditions and operating experience (OE) at the plant are bounded by the conditions and OE for which the GALL-SLR Report program was evaluated. If these bounding conditions are not met, it is incumbent on the applicant to address any additional aging effects and augment the AMPs for SLR.

RAI B.2.2.3-1

Background:

GALL-SLR Report AMP X.S1, "Concrete Containment Unbonded Tendon Prestress" program description states that the program consists of an assessment of measured tendon prestress forces from required examinations performed in accordance with Subsection IWL of the ASME Code, Section XI, as supplemented in 10 CFR 50.55a(b)(2)(viii) and AMP program elements.

Turkey Point Units 3 and 4 (PTN) Containment Inservice Inspection (CISI) program complies with ASME Code Section XI, Subsection IWL, 2007 Edition through 2008 Addenda. IWL-2500 requires a predetermined "common" tendon to be selected from the first year of randomly populated sample tendon groups (e.g., horizontal or hoop, vertical, dome); and that these tendons are inspected at each surveillance. To ensure that prestress concrete containment (PCC) structural integrity is maintained, the Code requires randomly selected and common tendons to be periodically inspected for material deterioration and prestress lift-off force reduction. The specific requirements for the selection and service role of random and common prestressed tendons are noted in IWL-2521, which states:

> One tendon of each type (as defined in Table IWL-2521-1) shall be selected from the first year inspection sample and designated as a common tendon. Each common tendon shall be examined during each inspection. A common tendon shall not be detensioned unless required by IWL-3300. If a common tendon is detensioned, another common tendon of the same type shall be selected from the first year inspection sample.

The common tendon provides a historical assessment of a group's performance that includes effects of prestress force losses from the initial (e.g., initial elastic shortening of concrete) effects to those that occur over-time (creep, shrinkage, and steel tendon relaxation) and allows for an unbiased correlation of the common tendon's losses to those of the randomly selected sampled tendons over the life of the plant. The "parameters monitored" program element of GALL-SLR Report AMP X.S1 discusses the importance of the historical assessment and recommends that

prestressing forces be measured on preselected common (control) tendons and tendons selected by random sampling of each tendon group using lift-off or equivalent tests.

Issue:

Attachment 2 to Audit Report "Turkey Point Units 3 and 4 - Audit of Structures and Civil Engineering Features," dated April 13, 1992 (ADAMS Accession No. ML17348B474), states that through the 15th year of surveillance, PTN Technical Specifications (TSs) required nine preselected tendons (3 horizontal or hoop, 3 vertical, 3 dome) to be examined for tendon lift-off force measurements at every surveillance. It also states that beginning with the 20th year surveillance TSs required lift-off force measurements of a random but representative sample of tendons (5 hoop, 4 vertical, 3 dome) with one "kept unchanged to develop a history" to assess the structural integrity of the PCCs every five years.

The staff audited PTN Procedure I2-ISI/IWL, "Reactor Containment Building-Concrete Containment Inservice Inspection Program," Revision 1, and noted that it states that the common tendons for the 20th through the 45th year inspections of Units 3 and 4 respectively are 51H18, 12V22, 3D08 and 62H82, 45V10, 3D20. However, in its review of the basis document PTN-BFSC-99-2205, "Containment Tendon Loss of Prestress Time Limited Aging Analysis (TLAA) for License Renewal and Subsequent License Renewal," it was not clear that the same "common" tendons had been selected for the first fifteen years of containment surveillance. The staff noted that in accordance with IWL-2521, common or controlled tendons should be selected from the first year sample and kept unchanged unless detensioned per ASME Code, Section XI, Subsection IWL-2521 and IWL-3300. Without testing the same "common" tendons during each inspection, it is not clear how an adequate tendon prestress force history (that is correlated to past and current observed lift-off force data of other randomly selected tendons) was developed. The staff needs additional information to verify that the lift-off data referenced in the application represent the loss of prestress history characteristically demonstrated by common tendons over the life of the plant.

Request:

1. From the pool of randomly selected or predetermined tendons state which are (or could be) identified as common tendons per IWL-2521, such that the tendon prestress force history data is clear and that observed data with past and future predictions can be correlated. Identify these in Figures 4.5-1 through 4.5-6 of the PTN SLRA to clearly describe the force history over the life of the plant; or

2. Justify an alternate method for demonstrating how each tendon group's loss of prestress historical assessment can be adequately predicted and age-managed such that their structural integrity intended function would be maintained through the subsequent period of extended operation (SPEO).

Section V - Relevant to SRP-SLR TLAA 4.5

RAI 4.5-1

Regulatory Background:

10 CFR 54.21(c)(1) requires the applicant to evaluate TLAAs. 10 CFR 54.21(a)(3) requires the applicant to demonstrate that the effects of aging for structures and components will be adequately managed so that the intended function will be maintained consistent with the current licensing basis for the period of extended operation. As described in SRP-SLR, an applicant may demonstrate compliance with 10 CFR 54.21(a)(3) by referencing the GALL-SLR Report and when evaluation of the matter in the GALL-SLR Report applies to the plant.

10 CFR 50.34(h)(3), "Conformance with the Standard Review Plan (SRP)," states:

> [t]he SRP was issued to establish criteria that the NRC staff intends to use in evaluating whether an applicant/licensee meets the Commission's regulations. The SRP is not a substitute for the regulations, and compliance is not a requirement. Applicants shall identify differences from the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the Commission's regulations.

Background:

The program description of GALL-SLR Report AMP X.S1 states that the program consists of an assessment of measured tendon prestress forces from required examinations performed in accordance with Subsection IWL of the ASME Code, Section XI, as supplemented in 10 CFR 50.55a(b)(2)(viii) and AMP program elements. It also states that NRC Regulatory Guide (RG) 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments," may be used as guidance related to calculation of prestressing losses and predicted forces.

For the prediction of prestress force losses, RG 1.35.1 recommends establishing upper and lower tolerance bands to describe (for each tendon) the limits of measured allowable tendon prestressing force evaluation following time dependent losses in concrete and prestressing steel. The RG states that "the chance is small that the measured prestressing force will agree quite closely with the predicted value." The RG also provides guidance in grouping/subgrouping tendons for constructing group tolerance bands for comparison of measured prestressing forces with the forces predicted at inspection time. Table 4.7-1, "Examples of Potential Plant-Specific TLAA Topics," of SRP-SLR Section 4.7, "Other Plant-Specific Time-Limited Aging Analyses," describes the predicted lower limit (PLL) as a plant specific TLAA that needs to be dispositioned in accordance with 10 CFR 54.21(c)(1)(i), (ii), or (iii) and 10 CFR 54.21(d) with acceptance criteria for each as follows:

- For 10 CFR 54.21(c)(1)(i): "The applicant must demonstrate that the analysis remains valid for the subsequent period of extended operation. The analysis remains valid because it is shown to be bounding even during the subsequent period of extended operation. No changes to the existing analysis are necessary."

- For 10 CFR 54.21(c)(1)(ii): "The applicant must demonstrate that the analysis has been projected to the end of the subsequent period of extended operation. The existing analysis is updated or recalculated to show acceptable results for the subsequent period of extended operation."
- For 10 CFR 54.21(c)(1)(iii): "The applicant must demonstrate that the effects of aging on the intended function(s) will be adequately managed for the subsequent period of extended operation. Appendix A.1 of this SRP-SLR [NUREG 2192] provides the acceptance criteria for programs and activities used to manage the effects of aging."

Section B.2.3.3, "Concrete Containment Unbonded Tendon Prestress," of PTN SLRA states that "[t]he calculation of prestressing losses, predicted upper limits and predicted lower limits for each tendon group is in accordance with the guidelines of the NRC RG 1.35.1." SLRA Section 4.5, "Concrete Containment Tendon Prestress," states that the PLL "force values are developed consistent with the guidance presented in [RG] 1.35.1" and that the PLL force values are "calculated for each tendon prior to the surveillances to estimate the magnitude of the tendon relaxation and concrete creep and shrinkage for the given surveillance period."

<u>Issue</u>:

Section 4.5 of PTN SLRA and "Responses to the August 2018 NRC On-Site Regulatory Audit Follow-Up Items," letter dated October 17, 2018 (a voluntary letter to supplement the SLRA based on staff's concerns expressed during the audit) (ADAMS Accession No. ML18292A641) do not state how the PLL and baseline predicted force (BPF) are dispositioned in accordance with 10 CFR 54.21(c)(1). Graphical representation of PLLs in Figures 4.5-1 through 4.5-6 of the SLRA and the "Responses to the August 2018 NRC On-Site Regulatory Audit Follow-Up Items," letter dated October 17, 2018, have the PLL for PTN's horizontal (or hoop), vertical, and dome tendons of PCCs and the alike BPF used in the reactor vessel closure head (RVCH) replacement projects projected as straight lines from the first surveillance to the end of SPEO. It is not clear from the graphs/text how the PLL and BPF are dispositioned in accordance with 10 CFR 54.21(c)(1) TLAAs. Specifically, whether the analyses:

- Remain valid and bounding through the SPEO (i.e., PLL and/or BPF are dispositioned as 10 CFR 54.21(c)(1)(i)); or
- Were revised to be valid through the SPEO (i.e., PLL and/or BPF are dispositioned as 10 CFR 54.21(c)(1)(ii)), or
- The aging effects associated with the TLAAs will be managed by an AMP or aging management activities in the same manner as described in the integrated plant assessment in 10 CFR 54.21(a)(3) during the SPEO (i.e., PLL and/or BPF are dispositioned as 10 CFR 54.21(c)(1)(iii)).

<u>Request</u>:

1. Given the itemized acceptance criteria of SRP-SLR for 10 CFR 54.21(c)(1) identify and explain how:
    - PLL TLAAs in Figures 4.5-1 through 4.5-6 of Section 4.5 of the PTN SLRA; and

- BPF TLAAs shown in Figures 4.5-7 through 4.5-10 in “Responses to the August 2018 NRC On-Site Regulatory Audit Follow-Up Items,” letter dated October 17, 2018,

are dispositioned in accordance with the requirements of 10 CFR 54.21(c)(1) and 10 CFR 54.21(d), as 10 CFR 54.21(c)(1)(i), (ii), or (iii).

RAI 4.5-2

Background:

The GALL-SLR Report AMP X.S1, “Concrete Containment Unbonded Tendon Prestress” program description states that the program consists of assessment of measured tendon prestress forces from required examinations performed in accordance with Subsection IWL of the ASME Code, Section XI, as supplemented in 10 CFR 50.55a(b)(2)(viii) and AMP program elements. The GALL-SLR Report AMP X.S1 states that trend lines are constructed based on the guidance provided in the NRC Information Notice (IN) 99-10, Revision 1, “Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments.” The GALL-SLR Report AMP X.S1 also recommends the use of NRC RG 1.35.1, “Determining Prestressing Forces for Inspection of Prestressed Concrete Containments,” for guidance related to calculation of prestressing force losses and predicted forces. IN 99-10 provides guidelines for the construction of regression trend lines and states that for statistically valid results the regression analysis for each group of tendons includes individual lift-off forces of sampled tendons during surveillances.

PTN’s CISI program complies with ASME Code Section XI, Subsection IWL, 2007 Edition through 2008 Addenda, which requires separation of PCC tendons from the overall population of tendons subject to examination when they are affected by repair/replacement activities. In accordance with the Code, affected tendons are to be subjected to the augmented examination requirements of IWL-2521.2 initiating one year after the repair/replacement activity as delineated in Table IWL-2521-2, “Augmented Examination Requirements Following Post-Tensioning System Repair/Replacement Activities,” (Item L2.10 “Tendon”) and as specified in Table IWL-2500-1, “Examination Category L-B, Unbonded Post-Tensioning System.” Tendons unaffected by repair/replacement activities should satisfy the requirements as presented in Table IWL-2500-1. Hence, for PCCs subjected to repair/replacement activities the Code requires examinations for two populations of tendons: (a) those that are not affected by the repair/replacement activities (i.e., original unaffected tendons), and (b) those that are affected. Consistent with the above program description of GALL-SLR Report AMP X.S1, PTN SLRA Section B.2.3.3 states:

> The adequacy of the prestressing force for each tendon group based on type (i.e., hoop, vertical, and dome) and other considerations (e.g., geometric dimensions, whether affected by repair/replacement, etc.) establishes (a) acceptance criteria in accordance with Subsection IWL and (b) trend lines constructed based on the guidance provided in NRC IN 99-10 (Reference B.3.44), “Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments.” The calculation of prestressing losses, predicted upper limits and predicted lower limits for each tendon group is in accordance with the guidelines of the NRC RG 1.35.1 (Reference B.3.18), “Determining Prestressing Forces or Inspection of Prestressed Concrete Containments.”

Issue:

The staff noted that a 2004 (Unit 3) and 2005 (Unit 4) RVCH replacement required PTN PCC cutouts and reinstallation/replacement of a number of horizontal (or hoop) and vertical tendons.

By letter dated October 17, 2018 (ADAMS Accession No. ML18292A641), the applicant supplemented SLRA Section 4.5 to provide information regarding monitoring time dependent characteristics of the tendons affected by the RVCH replacement PCC cutouts and also to add new Figures 4.5-7 through 4.5-10. The supplemental figures show, for the affected tendons, the minimum required value (MRV) line and the BPF as the lower bound tendon prestress force line in accordance with RG 1.35.1. These lines are supplemented with sporadic tendon lift-off force data results for tendons that were repaired or replaced, with some plots limited to just a single year of affected tendon lift-off force results. In addition, while PTN RVCH replacement took place 32 years after the start of reactor operations for each unit, with containment repairs completed one year apart at each unit, reported data in Figures 4.5-7 through 4.5-10 indicate the MRV and BPF lines extending from years one and five to fifty years of reactor operation. It is not clear whether the referenced figures' x-axes relate to the time span from the initial surveillance at the start of reactor operations or to the time from retensioning of repaired/replaced tendons to the end of SPEO. It is also not clear why Figures 4.5-7 and 4.5-9 indicate that initial augmented examination for Unit 3 took place about five years after that of Unit 4 shown in Figures 4.5-8 and 4.5-10, when it was reported that completion of RVCH repair/replacement activities for the two units was one year apart. The results of augmented examinations for both are discussed in staff audited PTN PSC-TP-N981-508 "Final Report for the 35th year containment IWL inspection – 35th year tendon surveillance at Turkey Point," dated May 25, 2007. In addition, it is not clear how plots containing a single year lift-off force data can be used for the IN 99-10 recommended trending so that there is reasonable assurance the structural integrity of PCCs with cutouts can be maintained through the end of the SPEO.

<u>Request</u>:

1. For information provided in SLRA Figures 4.5-7 through 4.5-10 clarify: (i) whether referenced years relate to surveillance at the start of reactor operations or to that of retensioning the repaired/replaced tendons and (ii) the time discrepancy in performance of augmented examinations shown in SLRA Supplement Section 4.5 figures versus those reported in the 35th year of PTN PSC-TP-N981-508, relevant to PTN RVCH repair/replacement activities.
2. Provide Tables of non-normalized initial tendon prestress lock-off forces and of subsequent non-normalized augmented examinations lift-off force data for the replaced or repaired vertical and horizontal (or hoop) tendons associated with the PCC RVCH cutouts. Indicate years of examination.
3. Update as necessary TLAA Figures 4.5-7 through 4.5-10 showing the MRV for horizontal (or hoop) and vertical prestress tendons extended through the end of SPEO. Provide trend lines for non-normalized lift off force data reported in request 2. If regression analysis for trending is not performed in accordance with IN 99-10 (using non-normalized initial lock-off and lift-off forces of the randomly selected tendons from the pool of the affected horizontal and vertical repaired or replaced sampled prestressed tendons), provide justification.

RAI 4.5-3

Background:

PTN's CISI program complies with ASME Code Section XI, Subsection IWL, 2007 Edition through 2008 Addenda. For each sampled tendon and at each lift-off tendon force examination, ASME Code Section XI, Subsection IWL-3221.1 states the acceptance criteria based on tendon's predicted prestress force and for its expected elongation.

GALL-SLR Report AMP X.S1, "Concrete Containment Unbonded Tendon Prestress" program description states that the program consists of assessment of measured tendon prestress forces from required examinations performed in accordance with Subsection IWL of the ASME Code, Section XI, as supplemented in 10 CFR 50.55a(b)(2) and AMP program elements. It also states that NRC RG 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments," may be used for guidance related to calculation of prestressing force losses and predicted forces. RG 1.35.1 provides guidance for the determination of low (PLL) and high (predicted upper limit (PUL)) forces based on the influence of time dependent variations due to shrinkage and creep of concrete; and relaxation of prestressing steel, provided the tolerance-adjusted base values are subtracted from each tendon's modified initial prestress force (F_i). The, PUL and PLL are the upper and lower bounds of long term F_i losses. Alternatively, the RG allows the designer to use the conservatively estimated design values as base values for the time-dependent factors where the line drawn using these values is considered now as the lower bound base line predicted force, or BPF.

The "monitoring and trending" program element of GALL-SLR Report AMP X.S1 states that the PLL, MRV, and trend lines are developed for each tendon group examined during the SPEO. The trend line represents the general variation of prestressing forces over time based on the actual measured forces in individual tendons for a specific tendon group. The "acceptance criteria" program element of GALL-SLR Report AMP X.S1 states that "if the trend line crosses the PLL line, its cause should be determined, evaluated, and corrected. The trend line crossing the PLL line is an indication that the existing prestressing forces in concrete containment could fall below the MRV."

The "scope of program" program element of PTN SLRA Section B.2.2.3, "Concrete Containment Unbonded Tendon Prestress," AMP is enhanced to include guidance of RG 1.35.1 for determining the adequacy of prestressing forces during the SPEO. Figures 4.5-1 through 4.5-6 of Section 4.5 of PTN SLRA and PTN letter dated October 17, 2018 (ADAMS Accession No. ML18292A641), provide a graphic representation of the PLL for horizontal (or hoop), dome, and vertical tendons through the SPEO. The PTN letter also includes Figures 4.5-7 through 4.5-10 that use the BPF as best estimate for time dependent horizontal (or hoop) and vertical prestress tendon force losses for RVCH replacement affected tendons.

Issue:

Staff audited PTN Bechtel Report C-SJ599-12 documents for each tendon group, surveillance lift-off force requirements resulting from the containment reanalysis for the 25th year and beyond. The report also defines the PLL based on low and high (over time) variations of recalculated design values used for creep, shrinkage, and relaxation of steel as outlined in RG 1.35.1 for horizontal (or hoop) and vertical tendons. For dome tendons, however, it is not clear how the PLL was calculated. It appears that the PLL in Figures 4.5-3 and 4.5-4 is adjusted to intersect the MRV exactly at eighty years of reactor operation. The staff reviewed PTN Report BFSC 99-2005, "Containment Tendon Loss of Prestress Time Line Aging Analysis (TLAA) for License Renewal and Subsequent License Renewal," Revision 2, the TLAA 4.5 basis document, and noted that the dome PLL is "adjusted" to intersect the MRV force at eighty years with further actions to be taken if surveillance data falls below the MRV. The staff audited PTN PSC 40th and 45th year Surveillance Reports, however, changed the RG 1.35.1 defined tendon prestress force lower bound from PLL for all prestress tendon groups (i.e., horizontal or hoop, dome, and vertical) to that of BPF. However, apparent lower bound in Figures 4.5-1 through 4.5-6 seems to be based on PLL, while those in Figures 4.5-7 through 4.5-10 seems to be based on BPF. It appears that the SLRA used two different approaches in defining group tendon force lower bounds. In view of the information provided in the 40th and 45th year Surveillance Reports, it is not clear which approach the applicant intends to use in constructing the lower bound for each tendon. It is also not clear whether the dome tendon lower bounds have considered aggregate variations of time dependent shrinkage and creep of concrete, and relaxation of prestressing steel as suggested by RG 1.35.1 to which the applicant subscribes.

Request:

1. For each group of tendons, horizontal (or hoop), dome, and vertical, clarify and justify which methodology (PLL or BPF) will be used in constructing the lower bound of tendon prestress forces for tendon lift-off force evaluation during the SPEO.
2. State whether and how an evaluation of dome prestress tendon force lower bounds was performed based on the guidance provided in RG 1.35.1 or justify an alternate approach that would consider over time losses due to material variability in the PTN's PCC dome tendons.

RAI 4.5-4

Background:

SRP-SLR Section 4.5, "Concrete Containment Unbonded Tendon Prestress Analysis," states that "[t]he prestressing forces generated by the tendons diminish over time due to losses in prestressing forces in the tendons and in the surrounding concrete." For plants dispositioning the TLAA in accordance with 10 CFR 54.21(c)(1)(iii), the SRP-SLR references the GALL-SLR Report AMP X.S1, "Concrete Containment Unbonded Tendon Prestress" as an acceptable AMP to monitor and assess concrete containment tendon prestressing forces. The SRP-SLR also states that the applicant should consider applicable portions of the operating experience noted in IN 99-10 as it might affect prestress tendon force losses.

SLRA Section B.2.2.3 states that the applicant's Concrete Containment Unbonded Tendon Prestress Program is an existing AMP that, with enhancements, will be consistent with the GALL-SLR Report AMP X.S1.

The GALL-SLR Report AMP X.S1, program description recommends that while assessment of the adequacy of prestress tendon lift-off force follows the ASME Code Section XI, Subsection IWL requirements, trending of the lift-off forces is based on the guidance of NRC's IN 99-10, "Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments [(PCCs)]." IN 99-10 states that proper comparison and trending analysis of lift-off forces is critical in determining the future trends of prestressing forces in PCCs. The IN 99-10 also states that for trending results to be statistically valid, the true variation in the loss of prestressing forces can only be obtained through a regression analysis using measured individual lift-off forces rather than the average of the lift-off forces of randomly selected tendons in the sampled tendon group.

The "monitoring and trending" program element of the GALL-SLR Report AMP X.S1 in part states:

> The trend line represents the general variation of prestressing forces with time based on the actual measured forces in individual tendons of the specific tendon group. The trend line for each tendon group is constructed by regression analysis of all measured prestressing forces in individual tendons of that group obtained from all previous examinations.

PTN SLRA Figures 4.5-1 through 4.5-6, also provided in PTN letter "Responses to the August 2018 NRC On-Site Regulatory Audit Follow-Up Items," dated October 17, 2018 (ADAMS Accession No. ML18292A641), and letter dated December 14, 2018 (ADAMS Accession No. ML18352A885), (which supplement the SLRA) include lift-off force measurements of preselected and randomly selected tendons.

Issue:

1. Attachment 2 to Audit Report "Turkey Point Units 3 and 4 - Audit of Structures and Civil Engineering Features," dated April 13, 1992 (ADAMS Accession No. ML17348B474), states that through the 15th year of surveillance lift-off force measurements were made on preselected tendons. The PTN PSC Report TP-N981-501, dated April 16, 2007, indicates that for the 35th year of tendon surveillance, tendon lift-off force evaluation at PTN PCCs is based on randomly selected tendons. During its audit, the staff noted that PTN Report BSFC-99-2005, "Containment Tendon Loss of Prestress Time Limited Aging Analysis

(TLAA) for License Renewal and Subsequent License Renewal," Revision 2, which is the TLAA 4.5 basis document, indicates that tendon lift-off force measurements made were subsequently plotted in graphs similar to those submitted as SLRA Figures 4.5-1 through 4.5-6 and used for trending to evaluate PCC structural integrity. It is not clear which of the tendons in SLRA Figures 4.5-1 through 4.5-6 are preselected and which are randomly selected.

2. In addition, the IN 99-10 states that a systematic way of correlating scattered tendon prestress lift-off forces for trending is with actual measured lift-off force data of randomly selected prestress tendons. It is also not clear whether the plotted lift-off force data is measured actual lift-off force data, normalized average lift-off force data, a mixture of the previous two, or a different approach in trending. Further, it is not clear why some preselected tendon lift-off forces (e.g., common tendons) have increased over time instead of diminishing.

It is not clear how the applicant's AMP is consistent with the GALL-SLR Report AMP X.S1 "monitoring and trending" program element and the guidance of IN 99-10, if the trended lift-off force data in SLRA Figures 4.5-1 through 4.5-6 does not represent the actual measured lift-off prestressing forces in individual tendons obtained from all previous examinations.

Request:

1. Provide a table of lift off force data for each group of tendons (i.e., horizontal or hoop, dome, vertical) that are plotted and used for trending in PTN SLRA Figures 4.5-1 through 4.5-6 and its subsequent supplements. Indicate which of these points are randomly selected, which are preselected, which belong to RVCH replacement, which are actual measured, which are normalized, and that are common (control) tendons.
2. For any of the preselected prestressed tendon force measurements in Request 1 that indicate an increased value over time, explain the reason for the increased value and justify their validity if used for trending.
3. Based on the response to Request 1, clarify whether the Concrete Containment Unbonded Tendon Prestress Program is consistent with the GALL-SLR Report AMP X.S1 recommendations that the prestressing force trend lines should be based on actual measured forces in individual tendons obtained from all previous examinations. If so, provide trend lines (for the randomly selected and common tendons) that only consider the actual lift-off force of the individual tendons from all previous examinations in accordance with GALL-SLR Report AMP X.S1 recommendations to follow the IN 99-10 trending methodology.
4. If the Concrete Containment Unbonded Tendon Prestress Program takes exception to the GALL-SLR Report AMP X.S1 recommendations for the construction of prestressing force trend lines:
   (a) Provide a description of FPL's proposed alternate approach for trending of the prestressing forces that details the methodology used in developing the lift off force data sets in Request 1.
   (b) Provide (for all preselected, including common tendons, and randomly selected tendons) the trend lines resulting from this alternate approach.
   (c) Justify the mathematical/statistical validity of the proposed alternate approach for trending such that assessments of the adequacy of the tendon prestressing forces could be made prior to crossing the PLL/BPF lines and corrective actions could be taken during the SPEO before there is a loss of intended function of the prestress tendons.