Exelon Generation.

10 CFR 50
10 CFR 51
10 CFR 54

March 5, 2019

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Peach Bottom Atomic Power Station, Units 2 and 3
Renewed Facility Operating License Nos. DPR-44 and DPR-56
NRC Docket Nos. 50-277 and 50-278

Subject: Response to NRC Audit Review Information Request – Application for Subsequent Renewed Operating Licenses – Section 4.6 Primary Containment Fatigue Analyses

References:

1. Letter from Michael P. Gallagher, Exelon Generation Company, LLC (Exelon) to NRC Document Control Desk, dated July 10, 2018, "Application for Subsequent Renewed Operating Licenses"
2. NRC Email (B. Brady to D. Distel), Peach Bottom Atomic Power Station Subsequent License Renewal Application Supplement – Section 4.6, dated February 12, 2019

In Reference 1, Exelon submitted the Subsequent License Renewal Application (SLRA) for the Peach Bottom Atomic Power Station, Units 2 and 3 (PBAPS).

The purpose of this letter is to provide additional information in response to the NRC information request items identified in Reference 2. The enclosure to this letter provides the PBAPS responses to the information request.

This letter contains no new regulatory commitments.

This submittal has been discussed with the NRC License Renewal Senior Project Manager for the PBAPS Subsequent License Renewal project.

If you have any questions, please contact Mr. David J. Distel, Licensing Lead, Exelon License Renewal Projects, at (610) 765-5517.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 5th day of March 2019.

Respectfully submitted,

Michael P. Gallagher
Vice President – License Renewal and Decommissioning
Exelon Generation Company, LLC

Enclosure: Response to NRC Audit Review Information Request – Application for Subsequent Renewed Operating Licenses – Section 4.6 Primary Containment Fatigue Analyses

cc: Regional Administrator – NRC Region I
NRC Senior Project Manager (Safety Review), NRR-DMLR
NRC Project Manager (Environmental Review), NRR-DMLR
NRC Project Manager, NRR-DORL – Peach Bottom Atomic Power Station
NRC Senior Resident Inspector, Peach Bottom Atomic Power Station
R.R. Janati, Pennsylvania Bureau of Radiation Protection
D.A. Tancabel, State of Maryland

Enclosure

Peach Bottom Atomic Power Station, Units 2 and 3

Response to NRC Audit Review Information Request – Application for Subsequent Renewed Operating Licenses – Section 4.6 Primary Containment Fatigue Analyses

(18 pages)

NRC Information Request C 4.6-1

Background:

Section 4.6.1, "Primary Containment Structures, Penetrations and Associated components with fatigue Analyses," of Peach Bottom Atomic Power Station Unit 2 and 3 (PBAPS) SLRA states that the bounding design cumulative usage factor (CUF) values are, for

- SRV Discharge Piping and Other Piping Attached to the Torus, 0.202
- Replacement RHR and various components of Core Spray Suction Strainers, 0.193 and 0.367

The SLRA also states that the TLAAs for these components are dispositioned in accordance with 10 CFR 54.21(c)(1)(iii). The SLRA further states that these components will be managed by the Fatigue Monitoring (B.3.1.1) program that monitors and tracks through the FatiguePro software the number of critical thermal, pressure, and seismic transients to ensure that the CUF for each analyzed component does not exceed the applicable limit based on the limiting locations of Torus (CS)/Torus Shell and Torus Penetrations (CS)/Torus Shell. The Fatigue Monitoring program includes requirements that initiate corrective actions if a CUF value exceeds 80 percent of the ASME Section III acceptance criteria.

For applicable structures and components (SCs), Section 4.6, "Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis," of the SRP-SLR states that "[t]he severities and the numbers of cycles of actual loadings for each cyclic load assumed in the underlying analyses should be verified against the numbers and severities of the actual loads projected for the subsequent period of extended operation" and that pursuant to 10 CFR 54.21(c)(1)(iii), the effects of aging on the intended function(s) of such SCs will be adequately managed for the subsequent period of extended operation (SPEO).

Issue:

Appendix Q.5.4.1, "Fatigue Analyses of Containment Pressure Boundaries: Analysis of Tori, Torus Vents, and Torus Penetrations," of the PBAPS UFSAR states:

> For low usage factor locations (40-year CUF < 0.4) the PBAPS new loads analyses of Tori, Torus vents, and Torus penetrations have been evaluated and determined to remain valid for the extended period of operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(i).

It is not clear why the TLAAs for the above analyzed components apparently maintaining CUFs < 0.4 to end of the SPEO and in contrast to the UFSAR, are dispositioned as 10 CFR 54.21(c)(1)(iii). It is also not clear whether the two monitoring locations (i.e., Torus (CS)/Torus Shell and Torus Penetrations (CS)/Torus Shell) could adequately assess the number and severities of cycles of loadings for:

- SRV Discharge Piping and Other Piping Attached to the Torus, and
- Replacement RHR and various components of Core Spray Suction Strainers

Question 1: - It is not clear why the TLAAs for the above analyzed components apparently maintaining CUFs < 0.4 to end of the SPEO and in contrast to the UFSAR, are dispositioned as 10 CFR 54.21(c)(1)(iii).

Response:

PBAPS UFSAR, Appendix Q.5.4.1, is a description of how this TLAA was evaluated and dispositioned in the first PBAPS LRA for 60 years. The CUF value of 0.4 or less was selected as a threshold for the 10 CFR 54.21(c)(1)(i) disposition. A new UFSAR Appendix will be added to the PBAPS UFSAR when the second renewed license is issued.

After the first renewed license was issued, PBAPS installed the SI:FatiguePro^{TM} software. As explained in SLRA Section 4.6.1, SI:FatiguePro^{TM} monitors two containment locations as documented on SLRA Table 4.3.1-3, locations 26 and 27. These two locations bound the "Safety Relief Valve (SRV) Discharge Piping", "Other Piping Attached to the Torus", and "Replacement RHR and Core Spray Suction Strainers". Therefore, the SLRA 10 CFR 54.21(c)(1)(iii) disposition for these components reflects that the program has monitored these locations as of 2018 and is appropriate for the second LRA (80 years).

The 10 CFR 54.21(c)(1)(iii) disposition results in the actual number of transients being monitored as opposed to a 10 CFR 54.21(c)(1)(i) disposition. For example, based on SLRA Tables 4.3.1-1 and 4.3.1-2, as of December 31, 2015, Unit 2 has experienced 57 SRV Lifts, no SSEs, no OBEs, and no LOCAs; and Unit 3 has experienced 36 SRV Lifts, no SSEs, no OBEs, and no LOCAs.

Question 2: - It is also not clear whether the two monitoring locations (i.e., Torus (CS)/Torus Shell and Torus Penetrations (CS)/Torus Shell) could adequately assess the number and severities of cycles of loadings for:

- SRV Discharge Piping and Other Piping Attached to the Torus, and
- Replacement RHR and various components of Core Spray Suction Strainers

Response:

The monitored locations of "Torus (CS)/Torus Shell" and "Torus (CS)/Unit 3 Torus Penetration N234B" (locations 26 and 27 on SLRA Table 4.3.1-3) bound the "Unit 2 and Unit 3 Safety Relief Valve (SRV) Discharge Piping", "Unit 2 and Unit 3 Other Piping Attached to the Torus", and the "Unit 2 and Unit 3 Replacement RHR and Core Spray Suction Strainers"; because the basis of the fatigue analyses for these components assumed the same transients and the same or more transient cycle occurrences, and the components experience alternate stresses that are less than or the same as those for the monitored locations (locations 26 and 27).

As recommended by GALL-SLR (NUREG-2192), the scope of Fatigue Monitoring Program (which uses SI:FatiguePro^{TM}) includes those mechanical or structural components with a fatigue TLAA or other analysis that depends on the number of occurrences and severity of transient cycles. The program ensures that the existing CLB fatigue analyses remain valid and within their allowable limits.

The CLB fatigue analyses for the evaluated components assumed transient definitions that specified temperature and pressure changes, and seismic loads that are assumed to occur at the evaluated component. The number of transient cycle occurrences is how many times each transient definition was assumed in the original fatigue analyses.

The CLB analyses calculated alternating stresses based on the transient definitions (e.g., thermal and pressure changes, and seismic loads) for small nodes on the component (e.g., finite element analysis). The analyses then selected the nodes with the greatest alternating stresses. Based on the greatest alternating stresses, the analysis then uses fatigue curves in ASME Section III to determine the maximum number of transient cycle occurrences which is allowed for the alternating stresses. The assumed number of transient cycle occurrences divided by the allowed number of transient cycle occurrences from the ASME Section III fatigue curves, is the resulting design CUF value. Therefore, since all the nodes on the component experience the same number of transient cycle occurrences, the design CUF value for the node with the greatest alternating stresses bounds all other nodes on the component.

This same logic applies to other containment components that were analyzed for fatigue, where the analyses assumed the same transient definitions and the same or more transient cycle occurrences; and the calculated alternate stresses are less than or the same as the bounding locations. During the implementation of SI:FatiguePro^{TM} at PBAPS, the SI:FatiguePro^{TM} vendor performed an evaluation of the containment component locations documented in SLRA Section 4.6.1. The evaluation concluded that the "Torus (CS)/Torus Shell" (location 27 on SLRA Table 4.3.1-3), the "Torus (CS)/Unit 3 Torus Penetration N234B" (locations 26 on SLRA Table 4.3.1-3), and "Torus (CS)/Unit 2 Torus Penetration N212" bound the remaining containment components documented in SLRA Section 4.6.1. It should be noted that, the "Torus (CS)/Unit 2 Torus Penetration N212" is monitored by SI:FatiguePro^{TM} for Unit 2, however it is not documented on SLRA Table 4.3.1-3 because the Unit 3 penetration (location 26) bounds the Unit 2 penetration with respect to 80-year projections.

Fatigue Monitoring Program procedures require that if an actual CUF value on a monitored location exceeds 80% of code acceptance criteria of 1.0, then the condition will be entered in the corrective action program and evaluated. The evaluation would include the evaluation of other components discussed in SLRA Section 4.6.1 which are not monitored by SI:FatiguePro^{TM}. In addition, if an actual plant transient occurs in which process parameters (e.g., temperature and pressure) are not bounded by the existing program transient definitions then the condition will be entered in the corrective action program and evaluated.

NRC Information Request C 4.6-2

Background:

Section 4.6.1, "Primary Containment Structures, Penetrations and Associated components with fatigue Analyses," of Peach Bottom Atomic Power Station Unit 2 and 3 (PBAPS) SLRA states that the bounding design CUFs for Unit 2 and Unit 3 primary containment structures, torus penetrations, and associated components are at:

- Torus Shell, (CUF of 0.942 at junction of the shell and ring girder)
- Torus Penetrations, (CUF of 0.992 at torus penetration 234B)
- Core Spray Suction Strainer support elements, (CUF of 0.661 at torus shell weldments).

SLRA Section 4.6.1 also states that the Fatigue Monitoring (B.3.1.1) program is credited with managing primary containment structures, penetrations, and associated components TLAAs based on the FatiguePro monitoring of CUFs at the following limiting locations:

- Torus (CS)/Torus Shell (projected 80-year CUF is 0.591 at penetration N234B)
- Torus Penetrations (CS)/Torus Shell (Projected 80-year CUF is 0.862)

and that corrective actions will ensue when 80 percent of these values are reached. The PBAPS SLRA dispositions these TLAAs as 10 CFR 54.21(c)(1)(iii)

For applicable structures and components (SCs), Section 4.6, "Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis," of the SRP-SLR states that "[t]he severities and the numbers of cycles of actual loadings for each cyclic load assumed in the underlying analyses should be verified against the numbers and severities of the actual loads projected for the subsequent period of extended operation" and that pursuant to 10 CFR 54.21(c)(1)(iii), the effects of aging on the intended function(s) of such SCs will be adequately managed for the subsequent period of extended operation (SPEO).

Issue:

Section 3.5.2.2.1.5, "Cumulative Fatigue Damage," of the PBAPS SLRA states:

> During the 1980's, elements of the PBAPS Units 2 and 3 primary containments were reanalyzed in response to discoveries, by General Electric and others, of unevaluated loads due to design basis events and safety relief valve (SRV) discharge. The load definitions include assumed pressure and temperature transient cycles resulting from SRV discharge and design basis loss of coolant accident (LOCA) events. Components of the primary containment that were analyzed included the torus shell, torus penetrations, the drywell-to-torus vent piping, SRV discharge piping, other piping attached to the torus, and the drywell to torus vent bellows. As such, these components were analyzed for fatigue and are considered TLAAs, which are addressed.

Section 4.3.1, "Transient Cycle and Cumulative Usage Projections for 80 Years," of the PBAPS SLRA also states:

> [M]ost nuclear power plants, including PBAPS Units 2 and 3, have experienced a significant declining trend in accumulation of transients over time, transient projections based on recent operating experience provides an accurate basis for future projections. Therefore, each transient was evaluated to determine if the recent 15-year trend had a consistent cycle accumulation rate; and if so, the 15-year rate was used for most transients to extrapolate the projected number of future occurrences beginning January 1, 2016 and ending at the end of the unit's 80-year life.

Sections 3.5.2.2.1.3, "Loss of Material Due to General, Pitting and Crevice Corrosion" and B.2.1.30, "ASME Section XI, Subsection IWE," of PBAPS SLRA provide an example of the Unit 2 torus shell state. These sections discuss an underwater examination that identified a local area of pitting/general corrosion with 0.126 inches of metal loss of the nominal 0.675-inch-thick torus shell plate.

The audited calculations (ADAMS Accession No. for in Office Audit to be included here) for torus shell and torus penetration CUFs assumed a plant life of 40 years. The PBAPS SLRA addresses a plant life double of that originally assumed, yet the projected CUFs for these locations to the end of the SPEO have been reduced roughly by 40 and 15 percent to 0.591 and 0.862, respectively. When reporting these CUFs for the torus shell, it is not clear whether PBAPS have considered cycle projections based on a declining trend in the accumulation of transients and CUF calculations and loss of material to the end of the SPEO. If so, it is not clear how such an approach would consider the severity of actual loadings in the declining trend of selected cycles. Furthermore, it is not clear what steps PBAPS plans to take for the monitored Torus (CS)/Torus Shell location having an 80-year CUF of 0.862 that exceeds 80 percent of the ASME acceptance criteria.

Additionally, the National Association of Corrosion Engineers (NACE) identifies corrosion-fatigue (https://www.nace.org/Corrosion-Central/Corrosion-101/Corrosion-Fatigue/) to be "the result of the combined action of an alternating or cycling stresses" and states:

> In a corrosive environment the stress level at which it could be assumed a material has infinite life is lowered or removed completely. Contrary to a pure mechanical fatigue, there is no fatigue limit load in corrosion-assisted fatigue.
>
> [...]
>
> Control of corrosion-fatigue can be accomplished by either lowering the cyclic stresses or by various corrosion control measures.

It is not clear whether the FatiguePro calculated CUFs at the two (or more?) monitored locations could be used to assess the fatigue condition for the entire torus shell, when the torus shell may experience elsewhere loss of material affecting fatigue and the calculated CUF values. It is also not clear whether the FatiguePro automated program could account for potential reduction in material thickness used in evaluation of stresses in applicable locations for CUF calculations. It is not clear what measures PBAPS plans to take when loss of material occurs affecting fatigue, potentially substantially reducing the fatigue life of affected components.

Question 3: - The PBAPS SLRA addresses a plant life double of that originally assumed, yet the projected CUFs for these locations to the end of the SPEO have been reduced roughly by 40 and 15 percent to 0.591 and 0.862, respectively. When reporting these CUFs for the torus shell, it is not clear whether PBAPS have considered cycle projections based on a declining trend in the accumulation of transients and CUF calculations and loss of material to the end of the SPEO.

Response:

The CUF values documented in SLRA Table 4.3.1-3 for the "Torus (CS)/Unit 3 Torus Penetration N234B" (location 26) and "Torus (CS)/Torus Shell (location 27)" are based on the 80-year projections in SLRA Tables 4.3.1-1 and 4.3.1-2.

The "Torus/Torus Shell" and "Torus Penetration" fatigue analyses which calculated a design CUF values of 0.942 and 0.992 respectively, assumed: 1) 800 SRV Lifts, 2) 1 SSE, 3) 5 OBEs, and 4) 11,390 chugging cycles during a design basis accident.

The 80-year projected CUF values for these components in SLRA Table 4.3.1-3 (locations 26 and 27) is 0.591 and 0.862 respectively. These values have been calculated based on the 80-year projected transient cycle occurrences in SLRA Tables 4.3.1-1 and 4.3.1-2 which are: 1) 800 SRV Lifts, 2) 1 SSE 3) 1 OBE, and 4) 3037 chugging cycles.

Note, the projection of 800 SRV Lifts over 80 years is very conservative when compared to the actual number of SRV Lifts as of December 31, 2015 (57 for Unit 2 and 36 for Unit 3).

With regards to how PBAPS manages torus shell loss of material and potential impacts on the Fatigue Monitoring Program, please refer to the response to question 7.

Question 4: - If so, it is not clear how such an approach would consider the severity of actual loadings in the declining trend of selected cycles. Furthermore, it is not clear what steps PBAPS plans to take for the monitored Torus (CS)/Torus Shell location having an 80-year CUF of 0.862 that exceeds 80 percent of the ASME acceptance criteria.

Response:

The 0.862 CUF value for location 27 of SLRA Table 4.3.1-3 is an 80-year projected value based on the above 80-year projected transient cycle occurrences for SRV Lift, SSE, OBE, and Chugging, which are very conservative. Existing Fatigue Monitoring Program procedures require that the condition is entered into the corrective action program should an actual CUF value exceed 80% of the code acceptance criteria of 1.0.

As of December 31, 2016, the actual CUF values for this component is 0.06085 for Unit 2 and 0.03843 for Unit 3. These low actual CUF values are because both units have experienced very few SRV Lifts (e.g. 57 and 36 as of December 31, 2016), no SSEs, no OBEs, and no Chugging cycles.

These actual CUF values (0.06085 and 0.03843) are significantly less that the original design CUF value of 0.942 and 80-year projected CUF value of 0.862.

However, should an actual CUF value calculated by SI:FatiguePro^{TM} exceed 80% of code acceptance criteria of 1.0, the condition will be entered into the corrective action program and evaluated. The evaluation would include the evaluation of other components in SLRA Section 4.6.1 which are not monitored by SI:FatiguePro^{TM}. Corrective actions may include a more rigorous analysis of the component to demonstrate that the design limit will not be exceeded during the second period of extended operation, a flaw tolerance analysis in accordance with Appendix L of ASME Code Section XI, or repair or replacement of the component.

If an actual plant transient occurs in which process parameters (e.g., temperature and pressure) are not bounded by the existing program transient definitions then the condition will be entered in the corrective action program and evaluated. In addition, if an actual plant transient occurs that is different from existing program transient definitions then the condition is entered in the corrective action program and evaluated. The evaluation could include the addition of a new program transient definition to the Fatigue Monitoring Program. An example of this is that the "Improper Start of Cold Recirculation Loop" and "Sudden Start of Pump in Cold Recirculation Loop" transients (17 and 18 on SLRA Tables 4.3.1-1 and 4.3.1-2) were added to the program in the 2011 timeframe due to site operating experience.

Question 5: - It is not clear whether the FatiguePro calculated CUFs at the two (or more?) monitored locations could be used to assess the fatigue condition for the entire torus shell, when the torus shell may experience elsewhere loss of material affecting fatigue and the calculated CUF values.

Response:

The monitored locations of "Torus (CS)/Torus Shell" and "Torus (CS)/Torus Penetration N234B" (location 26 and 27 on SLRA Table 4.3.1-3) bound the remaining components evaluated in SLRA Section 4.6.1 because the design basis fatigue analyses for these remaining components assumed the same transients, the same or less transient cycle occurrences, and experience alternate stresses that are the same or less than those for the monitored locations. Please see the response to question 2 (above) for additional details.

With regards to how PBAPS manages torus shell loss of material and potential impacts on the Fatigue Monitoring Program, please refer to the response to question 7.

Question 6: - It is also not clear whether the FatiguePro automated program could account for potential reduction in material thickness used in evaluation of stresses in applicable locations for CUF calculations.

Response:

SI:FatiguePro^{TM} does not account for a reduction in material thickness of the monitored components. In simple terms, the program monitors plant transient severities and the actual number of plant transient cycle occurrences and calculates accumulated CUF values using the alternating stresses that were developed in the original fatigue analyses based upon the original design conditions.

Question 7: - It is not clear what measures PBAPS plans to take when loss of material occurs affecting fatigue, potentially substantially reducing the fatigue life of affected components.

Response:

As recommended by the GALL-SLR (NUREG-2192), the Fatigue Monitoring Program (which uses SI:FatiguePro^{TM}) is a preventive program that manages fatigue damage of various components within the scope of license renewal. The scope includes those mechanical or structural components with a fatigue TLAA or other analysis that depends on the number of occurrences and severity of transient cycles. The program ensures that the fatigue analyses remain within their allowable limits, thus minimizing the likelihood of failures from fatigue induced cracking of the components caused by cyclic strains in the component's material. The Fatigue Monitor Program is not credited for managing loss of material.

The ASME Section XI, Subsection IWE aging management program specifies examinations of accessible surfaces to detect the aging effects of cracking, loss of material, and loss of preload as addressed in IWE-3500. Activities in this program include inspection and evaluation of degraded conditions. All degraded conditions, exceeding the IWE acceptance criteria, are entered into the corrective action program and evaluated. This includes the impact on the existing design, including relevant fatigue analyses. The acceptance criteria include separate criteria for global, uniform losses, as well as for localized isolated conditions. These IWE criteria were developed so that conditions meeting these criteria would have no impact on the overall global analysis, including the fatigue analyses. During the development of the acceptance IWE criteria, it was concluded that the fatigue analysis would not be affected after consideration of the types and limits of degradation described in the acceptance criteria. Conditions that exceed these criteria are reported to Engineering for final evaluation and disposition, which would include consideration of any impact on the fatigue analyses.

Significant degradation that could impact existing fatigue analysis would be evaluated and corrective actions would be taken (e.g., refining the impacted fatigue analysis to include the degradation, or repair or replacement).

However, the existing fatigue analyses are based on global analyses that are unaffected by isolated, localized loss of material that meet the acceptance criteria. The fatigue analyses incorporate inherent conservative inputs, assumptions, and methods to bound minor "loss of material" conditions.

For example, the torus shell fatigue analyses (which is the basis for the "Torus (CS)/Torus Shell" monitored location) assumed that the maximum pressure from an SRV Lift during a LOCA is applied on all surfaces of the torus shell and it was concluded that the maximum stresses on the shell, are located on torus shell elements at the edge of the torus shell where it is reinforced by the ring girders. These shell elements are located on each side of the ring girders over the entire 106-foot circumference of the torus shell. In addition, the analysis assumed a conservative stress concentration factor of 4.0 for this discontinuity. The resulting alternate stresses at these shell elements were then used to establish the bounding CUF value for the entire torus shell.

In contrast the 0.126-inch deep material loss (approximately 1/8" diameter) that was found in 2014 on the Unit 2 torus shell plate PL-2-02-03 is an insignificant area when compared to the total remaining material in the shell element at the edge of the ring girders. In addition, the degraded area is located 19 inches away from a ring girder and is therefore not located in the area of highest stresses.

This small degraded area was evaluated and concluded to be insignificant degradation with respect to the capabilities of the torus shell and was dispositioned as "acceptable as is". The corrosion products within the area were removed, the area was recoated, so that the corrosion mechanism was arrested.

NRC Information Request C 4.6-3

Background:

Section 4.6., "Primary Containment Structures, Penetrations and Associated components with fatigue Analyses," of Peach Bottom Atomic Power Station Unit 2 and 3 (PBAPS) SLRA states that the "original design for the Primary Containment for both units was in accordance with ASME Section III, Subsection B, 1965 Edition with addenda through the Summer of 1966 [...] did not require an evaluation of fatigue." Therefore, the following SCs have no fatigue TLAAs:

1. Drywell Shell
2. Drywell Head
3. Drywell Personnel Airlock
4. Drywell Equipment Hatches
5. Drywell CRD Removal Hatch
6. Drywell Electrical Penetrations
7. Drywell Mechanical Penetrations

For applicable structures and components (SCs), Section 4.6, "Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis," of the SRP-SLR states that Section III of the ASME Code allows for less rigorous treatment of fatigue parameters in design of components that have smaller or less frequent cyclic loadings (i.e., fatigue waivers). However, such fatigue parameter evaluations are to be considered as TLAAs. It also states:

> The current licensing basis may include fatigue waiver evaluations that preclude the need for performing CUF analyses of structural components. The ASME Code Section III rules for performing fatigue waiver evaluations for structural components are analogous to those in the Code for performing fatigue waiver evaluations of mechanical components.
>
> [...]
>
> In some instances, the applicant may identify activities to be performed to verify the assumption bases of the fatigue parameter evaluations, the fatigue analyses, or the fatigue waiver evaluations. Evaluations of those activities are provided by the applicant.

Issue:

The audited (ADAMS Accession No. for in Office Audit to be included here) PBAPS EXLNPB113-REPT-001, "Review of Containment Fatigue Analyses for Peach Bottom Second License Renewal," states that generic fatigue evaluations/waivers may be considered for:

1. Torus Electrical Penetration Assemblies
2. Drywell Shell
3. Drywell Head

The referenced by PBAPS SLRA Section 4.6, "Primary Containment Fatigue Analyses," Basis Document, Revision 0 (undated), ASME Section III Subsections A and B, 1965," in its Subsection N-415.1, "Vessels Not Requiring Analysis for Cyclic Operations," states:

> An analysis for cyclic operation is not required, and it may be assumed that the peak stress limit [...] has been satisfied for a vessel or part thereof by compliance with the applicable requirements for materials, design, fabrication, testing, and inspection [...] provided the specified operation of the vessel or part thereof meets [specific] conditions.

The referenced ASME Code states these conditions are associated for example with the number of cycles related to the cycling of vessel pressure from atmospheric to operating, the number of specified significant pressure fluctuations, temperature difference between any two points during normal, startup, and shutdown operations, etc.

The staff could not locate any applicable waivers for fatigue parameter evaluations for the noted plant operating conditions as discussed in PBAPS EXLNPB113-REPT-001. It is not clear how PBAPS would meet the evaluations of those activities for waiver of fatigue for Torus Electrical Penetration Assemblies, Drywell Shell, Drywell Head, or any other primary containment structure, penetration, and associated component subject to fatigue waiver conditions.

Question 8: - It is not clear how PBAPS would meet the evaluations of those activities for waiver of fatigue for (Drywell) Electrical Penetration Assemblies, Drywell Shell, Drywell Head, or any other primary containment structure, penetration, and associated component subject to fatigue waiver conditions.

Response:

Subsection N-415.1 is a requirement for vessel components designed to ASME Section III, 1965 as Class A components.

The above containment components were designed in accordance with ASME Section III Subsections A and B, 1965, as Class B components.

The requirements for Class B components start in ASME Section III (1965) in Subsection N-1100. Article 13 "Design" contains Subsection 1312(f) which states that Class B components shall be evaluated to Subsection N-414.1 (Primary Membrane Stresses), N-414.2 (Local Membrane Stresses), N-414.3 (Primary Membrane Plus Primary Bending Stresses Intensity), and N-414.4 (Primary Membrane Stresses Plus Secondary Stress Intensity). Subsection N-1312(f) does not require that Class B components are analyzed per Subsection N-415.1.

Consistent with these code requirements the original PBAPS containment design specification required analysis in accordance with Section III for Class B components. The original PBAPS containment design specification included the Drywell Electrical Penetration Assemblies, Drywell Shell, and Drywell Head. The specification did not require analysis in accordance with Subsection N-415.1. As a result, the containment design analysis evaluated containment components to Section III Subsections N-414.1, N-414.2, N-414.3, N-414.4, and N-414.5; but not N-415.1.

The EXLNPB113-REPT-001 report was an exploratory report which documented searches for containment fatigue analyses and waivers and provided recommendations to Exelon. The search did not identify fatigue analyses or fatigue waivers for Drywell Electrical Penetration Assemblies, Drywell Shell, and Drywell Head; which was expected. This report is not part of the PBAPS CLB. Exelon concluded that the recommendation cited above are not necessary since the ASME Section III code requirements were met in the original design.

It is noted that SLRA Section 3.5.2.2.1.6 documents that, although the original design of containment components did not include fatigue waivers, an assessment was performed for the SLRA application that had the containment been designed to a later ASME Section III version (which required wavier for containment components), the components would have met the six fatigue wavier criteria. This assessment is used to justify the ASME Section XI, Subsection IWE aging management program (B.2.1.30) exception that visual or surface examinations are not necessary on these containment components. An SLRA Supplement (Supplement 2, Change 20) was submitted to NRC on January 23, 2019 (ML19023A015) to provide additional information related to this assessment.

NRC Information Request C 4.6-4

Background:

Section 4.6.1, "Primary Containment Structures, Penetrations and Associated components with fatigue Analyses," of Peach Bottom Atomic Power Station Unit 2 and 3 (PBAPS) SLRA states that the bounding design CUFs for Unit 2 and Unit 3 Core Spray Suction Strainer support elements are limited to 0.661 at torus shell weldment locations.

For applicable structures and components (SCs), Section 4.6, "Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis," of the SRP-SLR states that "[t]he severities and the numbers of cycles of actual loadings for each cyclic load assumed in the underlying analyses should be verified against the numbers and severities of the actual loads projected for the subsequent period of extended operation" and that pursuant to 10 CFR 54.21(c)(1)(iii), the effects of aging on the intended function(s) of such SCs will be adequately managed for the subsequent period of extended operation (SPEO).

Issue:

The audited of SLRA Section 4.6, "Primary Containment Fatigue Analyses," Basis Document, Revision 0 (undated) references

- "Addendum 2 to Revision 1 to Spec No. NE-265, Nuclear Safety Related Specifications for ECCS Suction Strainers for the Limerick Generating Station Units 1 and 2 and Peach Bottom Atomic Power Station Units 2 and 3," dated February 28, 1998.
- "PM-1006, Fatigue Evaluation Torus Shell due to RHR Strainer Supports," "10104-22-0, Sargent and Lundy Design Report, Unit 2 ECCS Pump Suction Strainer – Ring Girder Stiffeners," dated December, 08,1998.
- "Sargent and Lundy Design Report 10104-22-01, "ECCS Pump Suction Strainer Ring Girder," dated May 14, 1998.

These indicate that the strainer supports have been designed, fabricated, and installed in accordance to ASME Code Section III, 1980 Edition including Winter 1981, Subsection NF and that the supports have ample design margin.

The staff notes that ASME Code Section III, Subsection NF provides for support fatigue analyses of linear members and their connections, subject to a number of loading cycles when in excess of 20,000(?) that potentially could result in component damage/fracture. It is not clear whether the strainer supports referenced in Section 4.6.1 of the PBAPS SLRA include linear elements and if so, how the noted CUF of 0.661 applies to such elements.

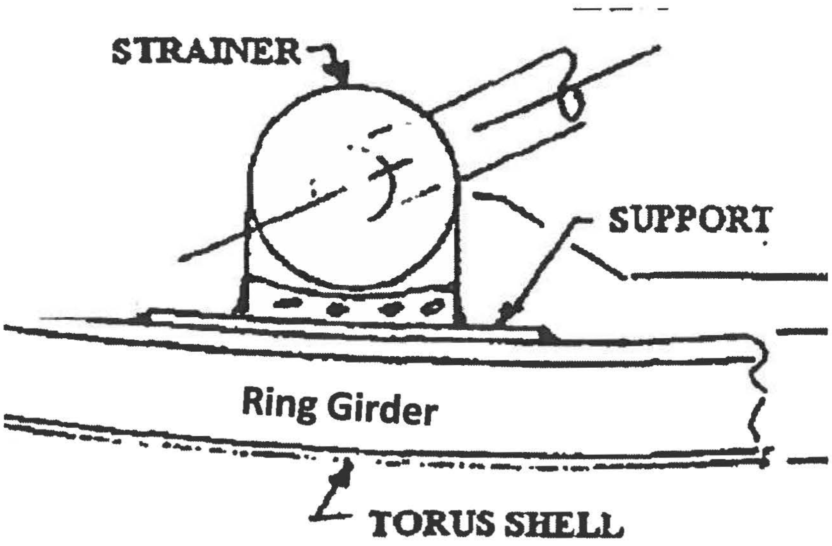
Question 9: - It is not clear whether the strainer supports referenced in Section 4.6.1 of the PBAPS SLRA include linear elements and if so, how the noted CUF of 0.661 applies to such elements.

Response:

Per ASME Section III, 1980, Subsection NF-1213, a Linear-Type Support is defined as acting under essentially a single component of direct stress. Such elements may also be subjected to shear stresses. Examples of such structural elements are tension and compression struts, beams and columns subjected to bending, trusses, frames, rings, arches, and cables.

The replacement RHR and Core Spray suctions strainers were installed in 1997 and 1998 and were designed per ASME Section III, 1980 through the 1981 Winter edition, Subsections NC, NE, and NF. These strainers are bolted cylindrical screen modules with internal supports, ribs, and stiffeners that are flanged to existing system piping. The cylindrical strainer modules are supported at the support legs which attach the strainers to the torus shell ring girders.

Below is an outline sketch of the strainer modules and how they are supported and attached at the torus shell.



The strainer modules, including the flanges to the system piping flanges, were designed to Section III Subsections NC and NE. The support legs which attach the strainers modules to torus shell ring girders were designed per Section III Subsection NF.

The strainer design included finite element modelling of the strainer modules, including the terminations points at the system piping flanges and the strainer support legs. Therefore, "Linear Type Supports" were evaluated both within the strainer modules and in the support legs. The resulting stresses from the finite element model were reviewed and the nodes on the models with the greatest alternating stress were evaluated for fatigue.

The usage of the support legs was concluded to have a CUF value of 0.661. This was based on the assumptions of:

1) 800 SRV Lifts, with each lift resulting in 13 loading cycles for a total of 10,400 loading cycles, and

2) 5 Design basis events which includes a DBA during an OBE with SRV lifts, with each event resulting in 9 loading cycles for a total of 630 loading cycles.

Therefore, the strainer support fatigue analysis assumed 11,030 loading cycles which does not exceed 20,000 cycles.

NRC Information Request C 4.6-5

Background:

Section 4.6.2, "Containment Process Line Penetration Bellows," of the PBAPS SLRA states that "the main steam lines, the feedwater lines, the HPCI steam line, the RHR supply and return lines, the RWCU pump suction line, the core spray discharge lines, and the vessel head spray line" were designed with penetration bellows. It also states, that "[t]he design specification for the original bellows specified 200 "startup-shutdown" cycles (as defined in [ASME Code] Section III) and a minimum of 1,500 "normal operating" (as defined in [ASME Code] Section III). It further states that the Unit 3 RHR supply and return line penetration bellows were replaced during 1988 and 1989, however, "[t]he design specification for the Unit 3, replacement penetration bellows specified 1,500 normal operating cycles," but did not specify 200 startup-shutdown cycles.

Section 4.6.2 of the SLRA also states that over an 80-year period Units 2 and 3 are projected to experience 186 and 140 "Heatup-Cooldown" transient cycles occurrences, respectively, "which are less than the specified 200 startup-shutdown transient cycle occurrences for the original containment bellows" and that for "both the original and replaced containment bellows, the specified 1500 'normal operating cycles' associated with a DBA is significantly greater than an assumed one DBA per unit." The section then concludes by stating that the "primary containment process line bellows fatigue analyses remain valid through the second period of extended operation" and dispositions these TLAAs as 10 CFR 54.21(c)(1)(i).

For applicable structures and components (SCs), Section 4.6, "Containment Liner Plate, Metal Containments, and Penetrations Fatigue Analysis," of the SRP-SLR states that "[t]he severities and the numbers of cycles of actual loadings for each cyclic load assumed in the underlying analyses should be verified against the numbers and severities of the actual loads projected for the subsequent period of extended operation" and that pursuant to 10 CFR 54.21(c)(1)(i), the SLRA must demonstrate that the analyses remain valid for the subsequent period of extended operation (SPEO).

Issue:

The audited SLRA Section 4.6, "Primary Containment Fatigue Analyses," Basis Document, Revision 0 (undated), references "Specification 6280-M-122, Specification for Containment Expansion Joints for the Peach Bottom Atomic Power Station Units 2 and 3," dated January 6, 1969 and "Design Specification for Replacement Containment Expansion Joints for Nuclear Service," dated September 2, 1987. These referenced documents provide background information for the original and replacement designs, construction, inspections, and installations of bellows assemblies that confirm PBAPS SLRA Section 4.6.2 statements for cyclic loadings.

The "Design Specification for Replacement Containment Expansion Joints for Nuclear Service," however, clearly states that the "equipment specified will be installed indoors at the Peach Bottom Atomic Power Station Units 2 and 3" and that the "effects of relative end point displacement[s] resulting from thermal and seismic movements shall be considered in the fatigue evaluation." It is not clear, whether PBAPS replaced the bellows assemblies at both Units, or just at Unit 3 and whether the design basis for replaced bellows assemblies was changed to include just normal operations cyclic loading typically associated with cycles in between startup-shutdowns and let-forego of cyclic loading associated with atmospheric temperature/pressure in one extreme and normal operating conditions in the other. It is also not clear how "relative end point displacement[s] resulting from thermal [...] movements" would account for startup-shutdown cyclic loadings required in the original design consistent with ASME code Section III, Paragraph N-412 (n) (1) and (n) (3), noted in Specification 6280-M-122. In addition, it is not clear how PBAPS equivalences the severities and the numbers of cycles associates with DBAs to those of normal cycles of operation.

Question 10: - It is not clear, whether PBAPS replaced the bellows assemblies at both Units, or just at Unit 3 and whether the design basis for replaced bellows assemblies was changed to include just normal operations cyclic loading typically associated with cycles in between startup-shutdowns and let-forego of cyclic loading associated with atmospheric temperature/pressure in one extreme and normal operating conditions in the other.

Response:
Although the design was applicable to both Units 2 and 3, only the Unit 3 RHR Process Line Bellows were replaced in the late 1980s during a major plant modification that replaced Recirculation System and RHR System piping. These replacement Unit 3 RHR Process Line Bellows were designed and qualified for 1500 cycles in which the bellows experience a temperature and pressure change from 150°F at 2 psig to 281°F at 56 psig. The 150°F at 2 psig conditions corresponds to containment conditions during normal plant operations and 281°F at 56 psig conditions corresponds to the containment design accident conditions. Therefore, these bellows were designed to exceed the maximum displacements associated with a DBA event which was assumed to occur 1500 times. Obviously, this is not credible and therefore represents significant margin. The design specification of the replacement bellows did not specify transients associated with plant Startup and Shutdown where containment conditions change from 70°F at 0 psig to 150°F at 2 psig and back. The associated displacements for this transient are significantly bounded by the larger displacements associated with the DBA transient.

Question-11: It is also not clear how "relative end point displacement[s] resulting from thermal [...] movements" would account for startup-shutdown cyclic loadings required in the original design consistent with ASME code Section III, Paragraph N-412 (n) (1) and (n) (3), noted in Specification 6280-M-122. In addition, it is not clear how PBAPS equivalences the severities and the numbers of cycles associates with DBAs to those of normal cycles of operation.

Response:

The original Unit 3 RHR System piping process line bellows were designed and installed to ASME Section III, 1968, Appendix IX, paragraph IX-200. This 1968 version of the Section III, paragraph N-412 (n) (1) and (n) (3) required evaluation of Startup/Shutdown transients and DBA transients. Therefore, the original design assumed 200 Startup/Shutdown transient cycle occurrences (with pressure and temperature changes from 0 psig at 70°F to 2 psig at 150°F and back) and 1500 DBA transient cycle occurrences (with pressure and temperature changes from 2 psig at 150°F to 56 psig at 281°F and back).

The displacements that were specified for design of the original bellows corresponded to the DBA event, since these displacements significantly bound those associated with the Startup/Shutdown transients.

The maximum allowable stresses and displacements for the original Unit 3 bellows (N-12, N-13A, and N-13B) were specified in the design specification as documented below.

Bellows	Max Axial Force (lbf)	Max Shear Force (lbf)	Displacement Max Axial Offset (inches)	Displacement Max Lateral Offset (inches)
N-12	960	5100	0.86	0.50
N-13A	1000	7600	0.86	0.54
N-13B	1000	7600	0.86	0.54

The vendor certificate of conformance demonstrated that these bellows met these requirements with margin.

The replacement Unit 3 RHR System process line bellows were designed to a later version of ASME Section III (1980 with Winter 1981 edition). As such the bellows were designed per Subsection NC-3649.4 of the later code and not Paragraph N-412 (n) (1) and (n) (3) of the 1968 code. This later version of the ASME Section III did not require the consideration of Startup/Shutdown transients.

The design of the replacement bellows assumed 1500 DBA transient cycle occurrences (pressure and temperature changes from 2 psig at 150°F to 56 psig at 281°F). The resulting maximum allowable stresses and displacement for these bellows (N-12, N-13A, and N-13B) were specified as follow.

Bellows	Max Axial Force (lbf)	Max Shear Force (lbf)	Displacement Max Axial Offset (inches)	Displacement Max Lateral Offset (inches)
N-12	960	5100	0.85	0.50
N-13A	1000	7600	0.85	0.54
N-13B	1000	7600	0.85	0.54

The vendor certificate of conformance demonstrated that the bellows met these requirements with margin.

The above tables show that even though the replacement bellows were designed to a later version of ASME Section III the resulting maximum displacements are essentially the same as the original. Therefore, the CLB design of the replacement bellows is consistent with the original.