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**SUSQUEHANNA STEAM ELECTRIC STATION
REQUEST FOR ADDITIONAL INFORMATION FOR THE
REVIEW OF THE SUSQUEHANNA STEAM ELECTRIC STATION
UNITS 1 AND 2, LICENSE RENEWAL APPLICATION (LRA)
SECTIONS B.2.8, B.2.9, 3.1.2, 3.2.2, 3.3.2, AND 3.4.2
PLA-6406**

**Docket Nos. 50-387
and 50-388**

References:

1) *PLA-6110, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Application for Renewed Operating License Numbers NPF-14 and NPF-22," dated September 13, 2006.*

2) *Letter from Ms. E. H. Gettys (USNRC) to Mr. B. T. McKinney (PPL), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station, Units 1 and 2 License Renewal Application," dated July 23, 2008.*

3) *PLA-6391, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station Units 1 and 2, License Renewal Application (LRA) Sections B.2.23, B.2.24, B.2.26, B.2.27, B.2.28, B.2.31," dated July 25, 2008.*

4) *PLA-6400, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station Units 1 and 2, License Renewal Application (LRA) Sections B.2.14, B.2.25, B.2.32, and B.2.33," dated August 12, 2008.*

5) *PLA-6401, Mr. B. T. McKinney (PPL) to Document Control Desk (USNRC), "Request for Additional Information for the Review of the Susquehanna Steam Electric Station Units 1 and 2, License Renewal Application (LRA) Sections 3.1, 3.2, 3.3, and 3.4," dated August 15, 2008.*

In accordance with the requirements of 10 CFR 50, 51, and 54, PPL requested the renewal of the operating licenses for the Susquehanna Steam Electric Station (SSES) Units 1 and 2 in Reference 1.

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Reference 2 is a request for additional information (RAI) related to License Renewal Application (LRA) Sections B.2.8, B.2.9, 3.1.2, 3.2.2, 3.3.2, and 3.4.2. The enclosure to this letter provides the question responses and the additional requested information.

There are no new regulatory commitments contained herein as a result of the attached responses.

If you have any questions, please contact Mr. Duane L Filchner at (610) 774-7819.

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

Executed on: 8/27/2008

for BT McKinney

B. T. McKinney

Enclosure: PPL Responses to NRC's Request for Additional Information (RAI)

Copy: NRC Region I
Ms. E. H. Gettys, NRC Project Manager, License Renewal, Safety
Mr. R. Janati, DEP/BRP
Mr. F. W. Jaxheimer, NRC Sr. Resident Inspector
Mr. A. L. Stuyvenberg, NRC Project Manager, License Renewal, Environmental

Enclosure to PLA-6406
PPL Responses to NRC's
Request for Additional Information (RAI)

RAI B.2.8-1:

The boiling water reactor (BWR) Penetrations Program takes an exception to the "scope of program" program element to the generic aging lessons learned (GALL) aging management program (AMP) XI.M8. In this exception, the applicant identifies that, in addition to the Standby liquid control (SLC) penetration and the reactor vessel (RV) instrumentation penetration, the program is credited for managing the effects of aging for the RV flange leakoff penetrations, RV drain penetrations, control rod drive penetrations, and RV incore flux monitoring penetrations. Although the BWR Penetrations Program is based on the recommended augmented inspection and flaw evaluation guideline criteria in Boiling Water Reactor Vessel and Internals Program (BWRVIP) Proprietary Topical Report Nos. BWRVIP-27 and BWRVIP-49, the staff has noted that the scope of BWRVIP-27 is limited to SLC penetration and that the scope of BWRVIP-49 is limited to BWR instrument penetrations. Provide your basis for extending the scope of the GALL AMP XI.M8 to the RV flange leakoff line penetrations, RV drain penetrations, control rod drive penetrations, and incore flux monitor penetrations, and for concluding that either the scope of the Topical Report No. BWRVIP-27 or BWRVIP-49 is applicable to the materials of fabrication, design aspects, and fabrication processes used in the fabrication of these additional penetrations.

PPL Response:

The basis for extending the scope of GALL AMP XI.M8 to the RV drain penetrations, control rod drive penetrations, and incore flux monitor penetrations is that GALL Chapter IV, item IV.A1-5 recommends crediting the BWR Penetrations Program and the BWR Water Chemistry Program to manage cracking for these components. GALL item IV.A1-5 explicitly names the following penetrations; control rod drive stub tubes, instrumentation, jet pump instrument, Standby Liquid Control (SLC), incore flux monitors, and vessel drain line. There is an inconsistency, however, between GALL item IV.A1-5 and the associated description for the BWR Penetrations Program in GALL Chapter XI, Section XI.M8. The discussion and guidance provided in GALL XI.M8 is limited to only the SLC and instrumentation penetrations. GALL XI.M8 provides no guidance for the other components listed in GALL item IV.A1-5.

In addition to the RV drain penetrations, control rod drive penetrations, and incore flux monitor penetrations, which are named in GALL item IV.A1-5, PPL extended this program to the RV flange leak off penetrations. While these penetrations are not named in GALL item IV.A1-5, the BWR Penetrations Program, as specifically defined for SSES in the program basis document, is an appropriate program to credit for managing cracking for these penetrations.

The SSES LRA Section B.2.8 identifies the inclusion of these additional penetrations (other than SLC and instrumentation) within the scope of the program as an exception to

GALL. The BWR Penetrations Program comparison to GALL, as stated in the program basis document, includes the details for aging management for all penetrations within the scope of the program. The program will inspect all in-scope penetrations in accordance with the requirements of ASME Section XI, augmented by the recommendations of approved BWRVIP reports. Inspections are scheduled in accordance with ASME Section XI, and examination results are evaluated in accordance ASME Section XI, IWB-3000. Acceptance of components for continued service is in accordance with ASME Section XI and, when applicable, BWRVIP guidance.

PPL has not concluded that the scope of either BWRVIP-27-A or BWRVIP-49-A is applicable to the RV flange leak off penetrations, RV drain penetrations, control rod drive penetrations, and incore flux monitor penetrations. However, NRC-approved BWRVIP guidance does exist for these penetrations. The SSES BWR Penetrations Program manages the control rod drive and flux monitor penetrations in accordance with the NRC-approved guidance in BWRVIP-47-A and BWRVIP-74-A. The RV flange leak off penetrations and the RV drain penetrations are being managed by NRC-approved guidance in BWRVIP-74-A. Thus, all penetrations are being managed by BWRVIP guidance that the NRC has previously approved as adequate for the period of extended operation.

RAI B.2.9-3:

The staff has noted that the scope of the license renewal application (LRA) AMP B.2.9 includes Topical Report BWRVIP-76, which has been approved by the staff and which provides the BWRVIP's recommended inspection and flaw evaluation guidelines for BWR core shrouds. Appendix C of the BWRVIP-76 report provides guidance to evaluate structural integrity of the core shroud welds that are exposed to neutron radiation during the service, discusses the usage of generic fracture mechanics analyses for establishing inspection intervals for core shroud welds containing cracks, and provides the notch fracture toughness values for irradiated stainless steel materials. The data in the appendix suggest that the fracture toughness values for stainless steel materials tend to decrease with increasing exposure to neutron fluences greater than 1x1021 n/cm2 (E>1 MeV). In August 2006, the BWRVIP issued staff-approved Topical Report No. BWRVIP-100-A, "Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds," which discussed and provided updated fracture toughness results for the irradiated stainless steel materials. The BWRVIP100-A report identified that the fracture toughness values for irradiated stainless steel material may actually be lower than those previously in the NRC-approved version of BWRVIP-76. Clarify whether the results and recommendations in the staff-approved BWRVIP-100-A are within the scope of AMP B.2.9 BWRVIP. If the recommendations in BWRVIP-100-A are within the scope of AMP B.2.9, clarify how the recommendations in BWRVIP-100-A will be used in conjunction with the recommendations in BWRVIP-76 for evaluations of cracking in core shroud welds. If the recommendations in BWRVIP-100-A are not currently within the scope of AMP B.2.9 but are being relied upon for aging management during the period of extended operation, clarify whether or not the LRA will be amended to include BWRVIP-100-A within the scope of AMP B.2.9, and clarify how the recommendations in BWRVIP-100-A will be used in conjunction with the recommendations in the staff-approved version of BWRVIP-76. If the recommendations in BWRVIP-100-A are not currently within the scope of AMP B.2.9 and are not being relied upon for aging management during the period of extended operation, justify why it is acceptable to use the recommendations in BWRVIP-76 for evaluation of postulated core shroud cracks without taking into account the updated fracture toughness assessment and values for irradiated stainless steel materials in BWRVIP-100-A.

PPL Response:

LRA Sections A.1.2.10 and B.2.9 state that the BWR Vessel Internals Program (AMP B.2.9) includes inspection and flaw evaluation in conformance with the guidelines of applicable and NRC-approved BWRVIP reports. As such, BWRVIP-100-A is currently within the scope of AMP B.2.9.

Under the BWR Vessel Internals Program, PPL is committed to follow the current, NRC-approved BWRVIP guidance to manage cracking of the core shroud during the period of extended operation.

The current, NRC-approved BWRVIP guidance for evaluating flaws in the high fluence core shroud welds is documented in BWRVIP-76, BWRVIP-99, and BWRVIP-100-A and requires the use of the updated fracture toughness results for irradiated stainless steel materials from BWRVIP-100-A. Until Appendix C of BWRVIP-76 is revised as recommended in BWRVIP-100-A, only those shroud welds that have fluences less than 1E21 n/cm^2 will have their inspection intervals determined using Table 2-1 of BWRVIP-76. For shroud welds that have fluences greater than 1E21 n/cm2, the inspection intervals will be determined on a case specific basis, in accordance with the guidance provided in BWRVIP-99 and BWRVIP-100-A.

RAI B.2.9-4:

The staff has determined that Susquehanna Steam Electric Station (SSES) credits its BWRVIP to manage reduction in fracture toughness in the following stainless steel RV internal components:

- Core shroud (including upper, intermediate, and lower shroud shells and welds – within the scope of BWRVIP-76)

- Core plate (including plate, beams, rim hold-down bolts and nuts, alignment assembly bolts and nuts and alignment pins – within the scope of BWRVIP-76)
- Top guide components (including beams and rim, alignment pins, bolts, nuts, and hold-down clamps)
- Orificed and peripheral fuel support pieces
- Control Rod Drive tubes
- Jet pump assemblies and their subcomponents
- Incore dry tubes from the source range and intermediate range monitors

The staff has determined (verified) that this AMP program is credited with limited aging management of reduction of fracture toughness in the RV internal components and that the program credits the augmented inspection and flaw evaluation criteria in NRC approved BWRVIP topical reports as the basis for managing the aging effects that are applicable to SSES RV and RV internal components. Loss (reduction) of fracture toughness is not an aging effect "per se" but instead refers to a change that may occur in the fracture toughness material property over time. Thus, the staff seeks additional information on how the recommended BWRVIP report guidelines within the scope of AMP B.2.9, BWRVIP, would accomplish adequate management of reduction of fracture toughness in these RV internal components. Provide your basis why the applicable BWRVIP inspection and flaw evaluation guidelines for these RV internal components are considered to be capable of managing reduction of fracture toughness in the components and clarify the methodology or methodologies in these reports that are credited for management of this aging effect.

PPL Response:

The orificed fuel support pieces are cast austenitic stainless steel, and reduction of fracture toughness (ROFT) of these pieces is managed by the Thermal Aging and Neutron Embrittlement of Cast Austenitic Stainless Steel (CASS) Program, not by the BWR Vessel Internals Program (BWRVIP), as shown in LRA Table 3.1.2-2 on LRA page 3.1-61. No further discussion of the orificed fuel support pieces is provided here.

The remaining reactor vessel (RV) internals components are the core shroud, core plate, top guide, fuel support pieces (peripheral), control rod guide tubes, jet pump assemblies, and incore dry tubes. The components are all addressed in specific BWRVIP reports, as listed in the table below.

BWRVIP Reports for the RV Internals in RAI B.2.9-4

Component	BWRVIP
Core shroud (including upper, intermediate, and lower shroud shells and welds)	BWRVIP-76
Core plate (including plate, beams, rim hold-down bolts and nuts, alignment assembly bolts and nuts and alignment pins)	BWRVIP-25
Top guide components (including beams and rim, alignment pins, bolts, nuts, and hold-down clamps)	BWRVIP-26-A BWRVIP-183
Peripheral fuel support pieces	BWRVIP-25
Control rod guide tubes	BWRVIP-47-A
Jet pump assemblies and their subcomponents	BWRVIP-41-A
Incore dry tubes from the source range and intermediate range monitors	BWRVIP-47-A

The applicable BWRVIP inspection and flaw evaluation guidelines for these RV internal components are considered to be capable of managing ROFT because the inspections are designed to detect cracking, and, if cracking is detected, the inspection intervals will be adjusted based on crack growth rates that are determined by evaluations that include the effects of ROFT. The BWRVIP guidelines represent the best available industry and regulatory guidance.

BWRVIP-99 and BWRVIP-100-A (specifically for the core shroud) provide additional information used to evaluate the crack growth rate in irradiated RV internals materials, when required by the applicable BWRVIP guidelines (as identified in the table above). BWRVIP-99 notes that irradiation (fluence) is one of the key factors affecting the crack growth rate. The crack growth rate increases as fluence increases the yield strength of the material (i.e., reduces fracture toughness).

The examination methods in the BWRVIP reports include ultrasonic examination and visual examination of the RV internal components, when accessible, for the detection of cracks. These same methods are credited for managing ROFT, since ROFT is managed as cracking is identified, evaluated, and monitored in components with fluence values exceeding the threshold for ROFT.

RAI B.2.9-5:

Reduction in ductility and fracture toughness can occur in stainless steel RV internal components when they are exposed to high energy neutrons (E>1 MeV). Appendix C of the BWRVIP-76 report provides guidance to evaluate structural integrity of the core shroud welds which is affected by the exposure to neutron radiation during the service. In this appendix, the BWRVIP discusses the usage of generic fracture mechanics analyses for establishing inspection intervals for the core shroud welds with cracks. Previous data suggests that the fracture toughness values tend to decrease when stainless steel materials are exposed to neutron fluence. Appendix C of the BWRVIP-76 report provides notch toughness values which can be used for irradiated stainless steel materials. In August 2006, the BWRVIP issued a staff-approved BWRVIP-100-A report, "Updated Assessment of the Fracture Toughness of Irradiated Stainless Steel for BWR Core Shrouds," which discussed and updated the fracture toughness results for the irradiated stainless steel materials. Clarify whether the results and recommendations in the staff-approved BWRVIP-100-A are within the scope of AMP B.2.9, BWRVIP. If the recommendations in BWRVIP-100-A are within the scope of AMP B.2.9, clarify how the recommendations in BWRVIP-100-A will be used in conjunction with the recommendations in BWRVIP-76 for evaluations of cracking in core shroud welds. If the recommendations in BWRVIP-100-A are not currently within the scope of AMP B.2.9 but are being relied upon for aging management during the period of extended operation, clarify whether or not the LRA will be amended to include BWRVIP-100-A within the scope of AMP B.2.9, and clarify how the recommendations in BWRVIP-100-A will be used in conjunction with the recommendations in the staff-approved version of BWRVIP-76. If the recommendations in BWRVIP-100-A are not currently within the scope of AMP B.2.9 and are not being relied upon for aging management during the period of extended operation, justify why it is acceptable to use the recommendations in BWRVIP-76 for evaluation of postulated core shroud cracks without taking into account the updated fracture toughness assessment and values for stainless steel internals in BWRVIP-100-A.

PPL Response:

The PPL response to RAI B.2.9-3, above, addresses this RAI.

RAI 3.1.2.2.2.3-1:

The staff noted that, in order to verify the effectiveness of the Water Chemistry Program in managing loss of material in the internal surfaces of the RV upper head and shell flanges, the applicant has credited its Inservice Inspection (ISI) Program to verify the effectiveness of the Water Chemistry Program in manage loss of material in the internal component surfaces that are exposed to the reactor coolant treated water environment. The staff verified that the current American Society of Mechanical Engineers (ASME) Code Section XI ISI requirements mandate, in part, a volumetric examination of the upper RV head-to-flange circumferential weld and RV shell-to-flange circumferential weld once every 10-Year ISI interval. Although Section IWA-2230 of the ASME Code

Section XI identifies that volumetric examination techniques are capable of indicating the presence of discontinuities (including flaws) throughout the volume of material being inspected, the staff seeks information on the volumetric inspection technique that is credited for these components and requests identification of the volumetric examination technique that is credited and will be used to verify the effectiveness of the Chemistry Program in managing loss of material in the RV shell-to-flange welds and RV upper head-to-flange welds.

PPL Response:

No volumetric examinations are credited to verify the effectiveness of the Chemistry Program in managing loss of material in the reactor vessel (RV) shell-to-flange weld and RV upper head-to-flange weld. The examination technique that is credited to verify the effectiveness of the Chemistry Program in managing loss of material for the RV shell-to-flange weld and RV upper head-to-flange weld is the visual examination (VT-3) performed per Category B-N-1 in Table IWB-2500-1 of ASME Section XI. Under the Inservice Inspection (ISI) Program, a VT-3 examination is required for the areas of the reactor vessel interior that are accessible during refueling outages, which includes the interior surface of the flange welds. In accordance with ASME Section XI, IWB-3520, the VT-3 examination identifies any abnormal corrosion or erosion. When abnormal corrosion or erosion is found, an engineering evaluation is performed. If the nominal section thickness has been reduced by more than 5%, further evaluation of the condition is required to determine the need for corrective actions. As required by the ISI Program, the identification and resolution of abnormal corrosion or erosion is controlled by the corrective action program. Thus, the ISI Program is an adequate program to verify the effectiveness of the Chemistry Program in managing loss of material of the reactor vessel interior surfaces, including the RV shell-to-flange weld and RV upper head-to-flange weld.

RAI 3.1.2.2.2.3-2:

The staff noted that SSES credits a combination of its BWR Chemistry Program and its BWRVIP to manage loss of material in the following stainless steel (including cast austenitic stainless steel) or nickel alloy RV internal components whose surfaces that are exposed to the treated water environment of the reactor coolant, and for those RV internals in a high neutron flux field, to an integrated neutron flux:

- RV recirculation nozzle and core spray nozzle thermal sleeves
- Shroud support access hole covers and adapter rings
- Core shroud (including upper, intermediate, and lower shroud shells and welds)
- Core plate (including plate, beams, rim hold-down bolts and nuts, alignment assembly bolts and nuts and alignment pins)

- Top guide components (including beams and rim, alignment pins, bolts, nuts, and hold-down clamps)
- Orificed and peripheral fuel support pieces
- Control Rod Drive tubes and tube bases
- Jet pump assemblies and their subcomponents
- SLC/core ΔP lines
- Incore guide tubes and incore dry tubes from the source range and intermediate range monitors
- Core spray line components (including piping, T-boxes, spargers, sparger nozzles, sparger elbows, and brackets)
- Steam dryer

The staff noted that SSES has aligned these aging management reviews (AMRs) for these components to the GALL AMR IV.A1-8. The GALL AMR IV.A1-8 recommends that the Water Chemistry Program be credited for aging management loss of material in RV shells, flanges, nozzles, penetrations, heads, and welds that are made from stainless steel, nickel alloy, or steel with internal stainless steel or nickel alloy cladding under internal exposure to the reactor coolant, and that an inspection program be credited to verify the effectiveness of the Water Chemistry Program in managing this aging effect. The staff is concerned that the AMP B.2.9 BWRVIP, which is based on implementation of NRC-approved BWRVIP guideline documents, may not actually be crediting actual inspections of all of these RV internal components. Justify why the AMRs on loss of material in these RV internal components have not been addressed in your discussion that is provided in LRA Section 3.1.2.2.2.3. In your justification, provide your basis for aligning these AMRs to the GALL AMR IV.A1-8 and for each stainless steel or nickel alloy RV internal component for which the BWRVIP is credited for management of loss of material, provide your technical basis why the BWRVIP is considered to be capable verifying the effectiveness of the Water Chemistry Program in managing loss of material in the components, or alternatively, providing for adequate management of loss of material in the component if the applicable NRC-approved BWRVIP guideline document does not actually credit an augmented inspection or inspections of the component.

PPL Response:

In the process of responding to previous RAIs, it was identified that the loss of material in these reactor vessel (RV) internal components was not addressed in the discussion in LRA Section 3.1.2.2.2.3. The LRA has been amended in response to RAI 3.1-1 and RAI 3.1-8 to add the discussion about the use of the BWR Water Chemistry Program and the BWR Vessel Internals Program (BWRVIP) for managing loss of material for the RV internals. The revision to LRA Section 3.1.2.2.2.3 is included in Attachment 1 of Reference 5.

The basis for aligning the subject RV internal components to GALL item IV.A1-8 is that it is considered to be the closest match for the aging effect of loss of material for the RV internals. GALL section IV.B1 addresses aging management review of BWR reactor vessel internals. However, the only item in IV.B1 for loss of material is IV.B1-15, which credits the BWR Water Chemistry Program and the Inservice Inspection (ISI) Program. This is not considered an appropriate match, since the ISI Program does not inspect the RV internals as comprehensively as the BWRVIP. GALL item IV.A1-8 is considered the closest match because it applies to reactor vessel components and credits the BWR Water Chemistry Program and a one-time inspection for verification.

The BWRVIP provides verification of the mitigation of loss of material through the performance of on-going, repetitive component inspections. The BWRVIP inspects accessible stainless steel and nickel alloy reactor vessel internals such as the core shroud, top guide, jet pump assemblies, core spray line components, and steam dryer. When these inspections determine that loss of material is not affecting these components, it verifies, on an on-going basis, that the BWR Water Chemistry Program is mitigating loss of material by controlling the chemical environment. It is then concluded that loss of material is being mitigated for components of like material exposed to the same chemical environment, including the thermal sleeves, shroud support access hole covers and adapter rings, core plate, fuel support pieces, control rod drive tubes, standby liquid control (SLC)/core ΔP lines, incore guide tubes and incore dry tubes. GALL XI.M32 for a one-time inspection allows the results from a representative sample to be applied to the entire population. As presented here, the use of the on-going BWRVIP inspections is considered to meet and exceed the GALL recommendation to use a one-time inspection to verify the effectiveness of the BWR Water Chemistry Program with mitigating loss of material for the subject reactor vessel internals.

RAI 3.1.2.2.2.3-3:

The staff has noted that the applicant has aligned its AMR on loss of material in the external surfaces of the reactor recirculation pump thermal barrier to the GALL AMR IV.C1-14 and that in this AMR, the applicant credits both its Water Chemistry Program and ISI Program to manage loss of material in the external surfaces that are exposed to the treated water environment of the reactor coolant. The staff determined that the crediting of the Water Chemistry Program for mitigation of loss of material/pitting and crevice corrosion is acceptable because the AMP is designed to prevent or mitigate loss of material that may be induced by corrosive aging mechanisms (e.g., such as pitting or crevice corrosion). However, the staff is concerned that it might not be appropriate to credit the ISI Program for aging management of loss of material in the external thermal barrier surfaces because they may be inaccessible for examination. Identify the type of ISI examination methods and requirements that will be used to monitor for and detect loss of material in the external surfaces of the recirculation pump thermal barriers and whether the external surfaces of the reactor recirculation pump thermal barriers are accessible for ISI examination method that is credited for aging management. Clarify which alternative aging management approach (if any) will be credited in addition to the Water Chemistry Program if it is determined that the external surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection.

PPL Response:

The external surfaces of the reactor recirculation pump thermal barriers are inaccessible for examination when the pump is assembled. Since the pumps are not disassembled on any periodic or planned frequency, the Inservice Inspection (ISI) Program is not an appropriate aging management program for loss of material.

An appropriate aging management approach is to credit the Chemistry Program Effectiveness Inspection to supplement the BWR Water Chemistry Program. As stated in the LRA Sections A.1.2.11, A.1.2.12, B.2.2 and B.2.22, the BWR Water Chemistry Program is supplemented by the Chemistry Program Effectiveness Inspection (CPEI) which provides verification of the effectiveness of the BWR Water Chemistry Program in mitigating the effects of aging. Although the external surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection, the CPEI will inspect other components of like material exposed to treated water to confirm that loss of material has been effectively mitigated or to detect any degradation that is occurring.

The line entry in LRA Table 3.1.2-3 is revised to credit the CPEI in place of the ISI Program. With this revision, the Table 3.1.2-3 entry is consistent with GALL item IV.C1-14, which is for stainless steel components exposed to reactor coolant (treated water) and subject to loss of material. The GALL item recommends the water chemistry program augmented by a one-time inspection to verify the effectiveness of the water chemistry control. The discussion in LRA Section 3.1.2.2.2.3 is also revised to note the use of CPEI with the BWR Water Chemistry Program. The LRA changes are included with the response to RAI 3.1.2.3.3.3-1.

A previous change to LRA Section B.2.22 added the Reactor Coolant System Pressure Boundary to the scope of the CPEI Program. That change is included in Attachment 3 of Reference 3.

RAI 3.1.2.2.11-1:

The staff has determined that, in the LRA Section 3.1.2.2.11 and in the AMR in LRA Table 3.1.2-2 on cracking of the steam dryers, the applicant credits a combination of AMP B.2.2, Water Chemistry Program, and AMP B.2.9, BWRVIP, for aging management of cracking in the steam dryers as a result of flow-induced vibrations. The staff is of the opinion that the applicant's crediting of the Water Chemistry Program does not provide a valid basis for aging management of cracking due to flow-induced vibrations in the steam dryers because flow-induced vibrations are a high-cycle fatigue phenomenon and are not dependent on the control of water chemistry impurity concentrations. The staff is also of the opinion that the applicant's BWRVIP, in its current form, does not provide a valid basis for managing cracking due to flow-induced vibrations in the steam dryers because: (1) the applicant's program does not currently include any enhancements and commitments to perform flow-induced vibration high cycle fatigue flaw growth calculations of the steam dryers, establish the flaw evaluation and corrective action recommendations on postulated steam dryer cracking, and establish the augmented inspection recommendations for the steam dryers (including establishing the inspection methods, sample size and frequency for the examinations to be performed), and (2) the BWRVIP reports on steam dryer flow-induced vibrations and cracking, as provided in BWRVIP Topical Report Nos. BWRVIP-139, BWRVIP-180, and BWRVIP-182, have yet to be approved by the staff or endorsed for use in the GALL AMP XI.M9, BWRVIP. Provide your technical and regulatory basis why the crediting of the Water Chemistry Program and the BWRVIP is considered to be valid management of cracking due to flow-induced vibrations in the steam dryers during the period of extended operation. Include in your response an explanation on whether any BWRVIP topical reports are being relied on for aging management of cracking in the steam dryers and whether or not AMP B.2.9, BWRVIP, needs to enhanced for adequate aging management of cracking due to flow-induced vibrations in the steam dryers.

PPL Response:

The BWR Water Chemistry Program does not manage cracking due to flow-induced vibration. The LRA is revised to delete the BWR Water Chemistry Program from the line entry for cracking of the steam dryers in LRA Table 3.1.2-2. This does not affect the GALL comparison, for which a note E remains appropriate.

The technical basis for crediting the BWR Vessel Internals Program (BWRVIP) for management of cracking due to flow-induced vibration in the steam dryers is that the SSES BWRVIP incorporates the best industry guidance that is currently available from BWRVIP reports BWRVIP-139, BWRVIP-181, and BWRVIP-182.

PPL will follow Section 6 of BWRVIP-139 when evaluating cracking in the steam dryer. PPL has instrumented the newly designed steam dryer in SSES Unit 1 to obtain data on the actual stresses in the dryer during current licensed power at extended power uprate (EPU) conditions. Based on the measured stresses, PPL will perform a flow-induced vibrational analysis. If any fatigue flaws are identified during the BWRVIP-required inspections, PPL can accurately calculate flaw growth and establish re-inspection intervals.

Currently, there is no regulatory basis for management of cracking due to flow-induced vibration in the steam dryers. GALL line item IV.B1-16 recommends a plant-specific program, which, in effect, acknowledges that there is no generically accepted or approved program for management of flow-induced vibration of the steam dryers. However, since the SSES BWRVIP includes provisions to incorporate all approved BWRVIP documents, or to file notice of exception, the program requires its own modification if the NRC requires changes to BWRVIP-139, BWRVIP-181, and BWRVIP-182 prior to their approval. Consequently, there is no need to enhance AMP B.2.9, the BWR Vessel Internals Program, at this time.

The LRA is amended as follows to make the necessary changes in response to this RAI.

- The text in LRA Section 3.1.2.2.11 (on LRA page 3.1-11) is revised by deletion (~~strikethrough~~).

3.1.2.2.11 Cracking due to Flow-Induced Vibration

Cracking due to flow-induced vibration for SSES stainless steel steam dryers exposed to reactor coolant is managed by ~~a combination of~~ the BWR Vessel Internals Program ~~and the BWR Water Chemistry Program~~.

- The text in LRA Table 3.1.1 (on LRA page 3.1-22) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

Table 3.1.1 Summary of Aging Management Programs for Reactor Vessel, Internals, and Reactor Coolant System Evaluated in Chapter IV of the GALL Report

Item Number	Component/Commodity	Aging Effect / Mechanism	Aging Management Programs	Further Evaluation Recommended	Discussion
3.1.1-29	Stainless steel steam dryers exposed to reactor coolant	Cracking due to flow induced vibration	A plant-specific aging management program is to be evaluated.	Yes, plant specific	~~A combination of t~~ ***T***he BWR Vessel Internals Program ~~and the BWR Water Chemistry Program~~ is credited to manage cracking of the steam dryer. Refer to Section 3.1.2.2.11 for further information.

- The text in LRA Table 3.1.2-2 (on LRA page 3.1-73) is revised by deletion (~~strikethrough~~).

Table 3.1.2-2 Aging Management Review Results - Reactor Vessel Internals

Component / Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG-1801 Volume 2 Item	Table 1 Item	Notes
Steam Dryer	Structural Integrity	Stainless Steel	Treated Water	Cracking	BWR Vessel Internals Program ~~BWR Water Chemistry Program~~	IV.B1-16	3.1.1-29	E
				Cracking - Fatigue	TLAA	IV.B1-14	3.1.1-05	A
				Loss of Material	BWR Water Chemistry Program BWR Vessel Internals Program	IV.A1-8	3.1.1-14	E

RAI 3.1.2.3.3.2-1:

The staff has noted that the applicant has a plant-specific AMR on loss of material in the internal surfaces of the reactor recirculation pump thermal barrier that are exposed to closed-cycle cooling water, and that in this AMR, the applicant credits both its Water Chemistry Program and ISI Program to manage loss of material in the internal surfaces that are exposed to closed-cycle cooling water. The staff determined that the crediting of the Water Chemistry Program for mitigation of loss of material/pitting and crevice corrosion is acceptable because the AMP is designed to prevent or mitigate loss of material that may be induced by corrosive aging mechanisms (e.g., such as pitting or crevice corrosion). However, the staff is concerned that it might not be appropriate to credit the ISI Program for aging management of loss of material in the internal thermal barrier surfaces because they may be inaccessible for examination. Identify the type of ISI examination methods and requirements that will be used to monitor for and detect loss of material in the internal surfaces of the recirculation pump thermal barriers that are exposed to closed-cycle cooling water and clarify whether the internal surfaces of the reactor recirculation pump thermal barriers are accessible for ISI examination method that is credited for aging management. Clarify which alternative aging management approach (if any) will be credited in addition to the Water Chemistry Program if it is determined that the internal surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection.

PPL Response:

The internal surfaces of the reactor recirculation pump thermal barrier consist of the bored channels that provide the flowpath for the Reactor Building Closed Cooling Water (RBCCW). These internal surfaces are inaccessible for inspection. As such, the Inservice Inspection (ISI) Program is not an appropriate aging management program for loss of material.

An appropriate aging management approach is to credit the Closed Cooling Water (CCW) Chemistry Program supplemented by the Chemistry Program Effectiveness Inspection (CPEI). As described in LRA Section B.2.14, the combination of these two programs will manage loss of material for stainless steel components exposed to closed cooling water. Although the internal surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection, the CPEI will inspect other components of like material exposed to CCW to confirm that loss of material has been effectively mitigated or to detect any degradation that is occurring. This is consistent with GALL item VII.C2-10, which is for stainless steel components exposed to closed cycle cooling water. The GALL item recommends the closed cooling water program for management of loss of material. It is noted that there is no direct comparison in GALL Section IV for the internal surfaces of the thermal barrier because GALL Section IV does not address a closed cooling water environment.

The line entry in LRA Table 3.1.2-3 is revised to credit the CPEI in place of the ISI Program and to note the comparison to GALL item VII.C2-10 and GALL Table 1 item 3.3.1-50. The revised entry for the reactor recirculation pump thermal barrier in a treated water, CCW (internal) environment with loss of material is consistent with GALL for material, environment, and aging effect, but a Note E is used because CPEI supplements the CCW Chemistry Program. The discussion in LRA Section 3.1.2.2.2.3 is also revised to note the use of CPEI with the CCW Chemistry Program. The LRA changes are included with the response to RAI 3.1.2.3.3.3-1.

Note that a previous change to LRA Section B.2.22 added the Reactor Coolant System Pressure Boundary to the scope of the CPEI Program (refer to Attachment 3 of Reference 3). The conforming changes to LRA Table 3.3.1, item 3.3.1-50 were made in response to RAI B.2.14-2 (refer to Attachment 1 of Reference 4).

RAI 3.1.2.3.3.3-1:

The staff has verified that the applicant includes a plant-specific AMR on cracking and flaw growth in the internal surfaces of the reactor recirculation pump thermal barrier that are exposed to the treated, closed-cycle cooling water environment, and in this AMR, the applicant credited both its Closed Cooling Water Chemistry Program and BWR Stress Corrosion Cracking Program to manage cracking and flaw growth in the internal component surfaces that are exposed to closed-cycle cooling water. The staff is of the opinion that it may not be appropriate to credit the BWR Stress Corrosion Cracking Program for aging management of cracking and flaw growth if the internal surfaces of the thermal barriers are located in areas that are inaccessible for examination. The staff is also of the opinion that it may not be appropriate to credit the Closed Cooling Water Chemistry Program for aging management if the cracking is induced by a mechanism other than an applicable chemistry-related or corrosion-related cracking mechanism.

Part A. Identify the type of examination(s) that will be credited and used under the BWR Stress Corrosion Cracking Program to monitor for and detect cracking and flaw growth in the internal surfaces of the recirculation pump thermal barriers that are exposed to closed-cycle cooling water, and clarify whether the internal surfaces of the reactor recirculation pump thermal barriers are accessible for the examination method(s) that is (are) credited for aging management. Clarify which alternative aging management approach (if any) will be credited in addition to the Closed Cooling Water Chemistry Program if it is determined that the internal surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection.

Part B. Clarify the aging mechanisms that are considered to be capable of inducing cracking and flaw growth in the internal surfaces of the reactor recirculation pump thermal barriers, and based on these mechanisms, provide your basis why the Closed Cooling Water Chemistry is considered to be a valid AMP for managing cracking and flaw growth in the internal surfaces of the reactor recirculation pump thermal barriers.

PPL Response:

Part A. The internal surfaces of the reactor recirculation pump thermal barrier consist of the bored channels that provide the flowpath for the Reactor Building Closed Cooling Water (RBCCW). These internal surfaces are inaccessible for inspection. As such, the BWR Stress Corrosion Cracking (SCC) Program is not an appropriate aging management program for cracking.

An appropriate aging management approach is to credit the Closed Cooling Water (CCW) Chemistry Program supplemented by the Chemistry Program Effectiveness Inspection (CPEI). As described in LRA Section B.2.14, these programs will manage cracking for stainless steel components exposed to closed cooling water. Although the internal surfaces of the reactor recirculation pump thermal barrier are inaccessible for inspection, the CPEI will inspect other components of like material exposed to CCW to confirm that cracking has been effectively mitigated or to detect any degradation that is occurring.

Part B. The aging mechanism capable of inducing cracking and flaw growth in the internal surfaces of the reactor recirculation pump thermal barriers is stress corrosion cracking (SCC). The pump thermal barrier is susceptible to SCC because it is made of stainless steel and is subjected to a closed cycle cooling water environment. Cracking due to SCC on the internal surfaces of the thermal barrier is mitigated by water chemistry control via the Closed Cooling Water Chemistry Program. This is consistent with GALL item VII.C2-11, which is for stainless steel components exposed to closed cycle cooling water. The GALL item recommends the closed cooling water program for management of cracking due to SCC. It is noted that there is no direct comparison in GALL Section IV for the internal surfaces of the thermal barrier because GALL Section IV does not address a closed cooling water environment.

The line entry in LRA Table 3.1.2-3 is revised to compare cracking of the internal surface of the thermal barrier to GALL line item VII.C2-11. While this provides a match with GALL for material, environment, and aging effect, a Note E is used because CPEI supplements the CCW Chemistry Program.

A previous change to LRA Section B.2.22 added the Reactor Coolant System Pressure Boundary to the scope of the CPEI Program. That change is included in Attachment 3 of Reference 3. The conforming changes to LRA Table 3.3.1, item 3.3.1-46 were made in response to RAI B.2.14-2, included in Attachment 1 of Reference 4.

The LRA is amended as follows to address this RAI response and the responses to RAI 3.1.2.2.2.3-3 and RAI 3.1.2.3.3.2-1:

- The text in LRA Section 3.1.2.2.2.3 (on LRA page 3.1-9) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

3.1.2.2.2.3 Flanges, Nozzles, Penetrations, Pressure Housings, Safe Ends, and Vessel Shells, Heads, and Welds

The BWR Water Chemistry Program is supplemented by the Inservice Inspection (ISI) Program for managing loss of material due to crevice and pitting corrosion for the steel reactor vessel upper head closure flange and shell closure flange with stainless steel cladding exposed to reactor coolant. A one-time inspection is not credited.

The BWR Water Chemistry Program alone is credited for managing loss of material due to crevice and pitting corrosion of the steel reactor vessel shell rings, ID attachments and welds, bottom head, nozzles, safe ends, and CRD stub tubes and housings with stainless steel cladding exposed to reactor coolant. A one-time inspection is not credited.

The BWR Water Chemistry Program in association with the ***Chemistry Program Effectiveness Inspection*** ~~Small Bore Class 1 Piping Inspection~~ or the Inservice Inspection (ISI) Program manages loss of material due to pitting and crevice corrosion for stainless steel components of the reactor coolant system (RCS) pressure boundary exposed to reactor coolant. The ***Chemistry Program Effectiveness Inspection*** ~~Small Bore Class 1 Piping Inspection~~ is a one-time inspection.

The Closed Cooling Water Chemistry Program in association with the Chemistry Program Effectiveness Inspection manages loss of material due to pitting and crevice corrosion for the internal surfaces of the stainless steel reactor recirculation pump thermal barriers.

The BWR Water Chemistry Program in association with the Chemistry Program Effectiveness Inspection manages loss of material due to pitting and crevice corrosion for the external surfaces of the stainless steel reactor recirculation pump thermal barriers.

> The Chemistry Program Effectiveness Inspection was substituted for the Small Bore Class 1 Piping Inspection (two places in the third paragraph above) in Attachment 3 of Reference 3. The changes are repeated here for consistency.

- The text in LRA Table 3.1.2-3 (on LRA page 3.1-83) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

Table 3.1.2-3 Aging Management Review Results – Reactor Coolant System Pressure Boundary

Component / Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG-1801 Volume 2 Item	Table 1 Item	Notes
Pump thermal barrier (reactor recirculation pump)	Pressure Boundary	CASS	Treated Water - CCW (Internal)	Loss of Material	CCW Chemistry Program ~~Inservice Inspection (ISI) Program~~ ***Chemistry Program Effectiveness Inspection***	~~N/A~~ ***VII.C2-10***	~~N/A~~ ***3.3.1-50***	***E*** ~~G~~
				Cracking	~~BWR SCC Program~~ CCW Chemistry Program ***Chemistry Program Effectiveness Inspection***	~~N/A~~ ***VII.C2-11***	~~N/A~~ ***3.3.1-46***	***E*** ~~H~~
			Treated Water - RCS (External)	Loss of Material	BWR Water Chemistry Program ~~Inservice Inspection (ISI) Program~~ ***Chemistry Program Effectiveness Inspection***	IV.C1-14	3.1.1-15	***A*** ~~E~~

RAI 3.1.2.3.3.4-1:

The staff noted that the N15 RV drain nozzles are designated as alloy steel nozzles without stainless steel or nickel-alloy cladding. The staff noted that the applicant credits its BWR Water Chemistry Program (in part) to manage cracking and flaw growth in these components. BWR Water Chemistry Programs are valid programs for management of cracking/flaw growth if the mechanisms inducing cracking and flaw growth are chemistry-related or corrosion-related cracking/flaw growth mechanisms. These mechanisms include mechanisms such as stress corrosion cracking (SCC), primary water stress corrosion cracking (PWSCC), intergranular stress corrosion cracking (IGSCC), or intergranular attack (IGA). To date, SCC, PWSCC, IGSCC or IGA have not been identified as aging mechanisms of concern for steel materials (including carbon steels and alloy steels). Thus, the staff is of the opinion that the BWR Water Chemistry Program will only be a valid program to credit if cracking/flaw growth in the drain nozzles is induced by either SCC, PWSCC, IGSCC or IGA.

Part A. Identify the weld material that was used to fabricate the N15 RV drain nozzle-to-vessel welds.

Part B. Identify the aging mechanisms that are capable of inducing cracking and flaw growth in the N15 RV drain nozzles and their associated nozzle-to-vessel welds, and based on these mechanisms, to provide your basis why the BWR Water Chemistry is considered to be a valid AMP for managing cracking and flaw growth in these components.

PPL Response:

Part A. The N15 RV drain nozzles were constructed by boring a hole through the bottom head of the reactor vessel and then welding a short length of a forged pipe (nozzle) to the outside surface of the bottom head. The weld material between the low alloy nozzle (SA-508 Class 1) and the low alloy vessel (SA-533 Grade B) is low alloy steel, compatible with the vessel and nozzle materials. The weld consists of two parts; the weld buildup on the outside diameter of the bottom head of the vessel, and the weld between the nozzle and the weld buildup. The weld buildup material is E8018-G, trade name Atom Arc 8018NM, conforming to the current specification for E8018-NM1. The material for the weld between the nozzle and the weld buildup is equivalent to E8018-NM, trade name Adcom 1NMM.

The line entry for drain nozzle N15 in LRA Table 3.1.2-1 (LRA page 3.1-45) identifies the drain nozzle as low alloy steel with partial stainless steel (SS) clad. The SS cladding is only on the inside diameter of the bottom head of the vessel, extending just slightly into the bore from the inside diameter of the vessel. There is no cladding on the inside diameter of the vessel bore hole, the weld, or the drain nozzle.

Part B. The aging mechanism that is capable of inducing cracking and flaw growth in the N15 RV drain nozzle and associated weld is crack initiation and flaw growth due to thermal and mechanical loading. The BWR Water Chemistry Program does not mitigate cracking caused by this mechanism. LRA Table 3.1.2-1 and line item 3.1.1-40 in Table 3.1.1 are revised to remove the BWR Water Chemistry Program from this entry.

- The text in LRA Table 3.1.1 (on LRA page 3.1-24) is revised by addition (***bold italics***) and deletion (~~strikethrough~~).

Table 3.1.1 Summary of Aging Management Programs for Reactor Vessel, Internals, and Reactor Coolant System Evaluated in Chapter IV of the GALL Report

Item Number	Component/Commodity	Aging Effect / Mechanism	Aging Management Programs	Further Evaluation Recommended	Discussion
3.1.1-40	Stainless steel and nickel alloy penetrations for control rod drive stub tubes instrumentation, jet pump instrument, standby liquid control, flux monitor, and drain line exposed to reactor coolant	Cracking due to stress corrosion cracking, Intergranular stress corrosion cracking, cyclic loading	BWR Penetrations and Water Chemistry	No	Consistent with NUREG-1801. The BWR Penetrations Program in conjunction with the BWR Water Chemistry Program is credited to manage cracking of nickel alloy and stainless steel materials for nozzles, safe ends, flux monitor housing, and control rod drive stub tubes. The ***BWR Penetrations Program alone is*** ~~combined programs are also~~ credited to manage cracking of the steel drain nozzle (N15)~~ with partial stainless steel cladding~~.

- The text in LRA Table 3.1.2-1 (on LRA page 3.1-45) is revised by deletion (~~strikethrough~~).

Table 3.1.2-1 Aging Management Review Results – Reactor Pressure Vessel

Component / Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG-1801 Volume 2 Item	Table 1 Item	Notes
Nozzle N15 Drain	Pressure Boundary	Low Alloy Steel with partial SS clad	Treated Water (Internal)	Cracking – Flaw Growth	BWR Penetrations Program ~~BWR Water Chemistry Program~~	IV.A1-5	3.1.1-40	F

Additional RAIs on AMRs for Polymer/Elastomers

RAI 3.2.2.2.5-1:

In LRA AMP B.2.32, Systems Walkdown Program, the applicant credits the program, in part, for aging management of both cracking and changes in material properties for elastomers (i.e., neoprene or rubber) and plastic (polymer) components that are exposed to uncontrolled indoor air or ventilation environments. The applicant indicates that cracking is an applicable aging effect for neoprene flexible connections (ductwork) in the primary containment atmosphere circulation. However, in LRA Table 3.2.2-7, the applicant does not include cracking as an applicable aging effect requiring management (AERM) for the flexible neoprene standby gas treatment system (SGTS) connections that are exposed internally to the ventilation environment or externally to the uncontrolled indoor air environment. Provide your basis why LRA Table 3.2.2-7 does not include any AMRs on cracking of the neoprene flexible SGTS connections that are exposed internally to the ventilation environment or externally to the uncontrolled indoor air environment, when in contrast, LRA AMP B.2.32 implies that cracking could occur in neoprene components. If cracking is determined to be an applicable AERM for the internal and external surfaces of these flexible SGTS connections, the staff requests that PPL amend the LRA Table 3.3.2-7 to include AMR's that identify cracking as an AERM for the internal and external surfaces of the components, and clarify the AMP or AMPs that will be credited for management of cracking in the neoprene flexible SGTS connection surfaces that are exposed to the uncontrolled indoor air and ventilation environments.

PPL Response:

Change in material properties and cracking due to thermal exposure were identified as aging effects requiring management for the neoprene flexible connections in the SGTS that are exposed internally to the ventilation environment and externally to the uncontrolled indoor air environment. Based on review of LRA Table 3.2.2-7, it was determined that cracking was inadvertently omitted from the "Aging Effect Requiring Management" column.

The System Walkdown Program is credited as the AMP for managing both change in material properties and cracking of neoprene exposed to the ventilation environment and the indoor air environment of the SGTS.

The LRA is amended as follows:

- Section 3.2.2.2.5 (on LRA page 3.2-12) is revised by addition (***bold italics***) and by deletion (~~strikethrough~~).

3.2.2.2.5 Hardening and Loss of Strength due to Elastomer Degradation

The System Walkdown Program is credited with managing degradation due to aging of the visible external surfaces~~, and in some cases the internal surfaces,~~ of these components. ***Because the relevant conditions for aging that exist in the internal environment are essentially the same as those that exist in the external environment, the System Walkdown Program is also credited with managing degradation due to aging of the internal surfaces.***

- The line item for neoprene exposed to ventilation (internal) and indoor air (external) (on LRA page 3.2-100) is revised by addition (***bold italics***).

Table 3.2.2-7 Aging Management Review Results - Standby Gas Treatment System

Component / Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG 1801 Volume 2 Item	Table 1 Item	Notes
Flexible Connections (Ductwork)	Pressure Boundary	Neoprene	Ventilation (Internal)	***Cracking***	***System Walkdown Program***	***V.B-4***	***3.2.1-11***	***E, 0217***
				Change in Material Properties	System Walkdown Program	V.B-4	3.2.1-11	E, ***0217***
			Indoor Air (External)	***Cracking***	***System Walkdown Program***	***V.B-4***	***3.2.1-11***	***E, 0217***
				Change in Material Properties	System Walkdown Program	V.B-4	3.2.1-11	E, ***0217***

- The plant-specific note is added on LRA page 3.2-105 (***bold italics***).

Plant-Specific Notes:	
0217	***AMP manages cracking and change in material properties due to ionizing radiation and thermal exposure (referred to as hardening and loss of strength/elastomer degradation in GALL).***

RAI 3.2.2.3-1:

The staff has noted that, in the LRA, the applicant appears to take an inconsistent approach to aging management of elastomeric, rubber, polymeric, and glass components in the application because in some AMRs for these types of materials the applicant has identified that cracking and changes in material properties as applicable AERMs, whereas in other AMRs for these types of materials, the applicant has concluded that AERMs are not applicable to the components. The staff seeks consolidation of PPL's approach to management of aging in the elastomeric, rubber, and polymeric engineered safety features system components with the aging management approach that the applicant had taken for these types of components in the auxiliary systems.

Part A. Provide your basis why PPL has not identified any AERMs for high-pressure coolant injection (HPCI) synthetic rubber component surfaces that are exposed to lubricating oil and to indoor air environments when cracking and changes in materials had been identified as applicable aging effects for: (1) neoprene and rubber components in the primary containment atmosphere circulation system under exposure to indoor air and to ventilation air, (2) neoprene/fiberglass components in the reactor building heating, ventilating, and air conditioning (HVAC) system under exposure to indoor air and to ventilation air, and (3) for Teflon piping in the sampling system (changes in material properties only) under exposure to indoor air.

Part B. Identify those material properties and aging effects that could be impacted by exposure of these synthetic rubber materials to the lubricating oil and indoor air environments.

PPL Response:

Part A. PPL has not identified any aging effects requiring management for the high-pressure coolant injection (HPCI) synthetic rubber component surfaces that are exposed to lubricating oil and indoor air, based on the following discussion.

A change in material properties and subsequent cracking of elastomers, such as synthetic rubber, could result from exposure to ionizing radiation, high temperatures, or ultraviolet radiation or ozone.

Ionizing radiation is an applicable aging mechanism for synthetic rubber components only if they are exposed to a total integrated dose (TID) equal to or greater than 10E6 rads. The subject HPCI flexible connections (hoses) are located in the HPCI pump rooms in the reactor building. The maximum expected (i.e., most conservative) TID in the HPCI pump rooms, under normal operating conditions for the current license period of forty (40) years, is 3.5x10E4 rads. For sixty (60) years, the dose is 5.3x10E4 rads, or 1.5 times the 40-year dose. Additionally, the lubricating oil environment of the HPCI

System contains no contributors to the TID in the HPCI pump rooms. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for the synthetic rubber flexible connections of the HPCI System that are exposed to indoor air (external) or lubricating oil (internal).

Thermal exposure is an applicable aging mechanism for synthetic rubber components only if they are exposed for prolonged periods to a temperature of 95°F or higher. The ambient air temperature range in the HPCI pump rooms in the reactor building, under normal operating conditions, is 60°F to 100°F. However, considering that there are no significant sources of heat within these rooms during normal plant operation, it is reasonable to assume that the external surface temperature of the synthetic rubber components will not exceed 95°F for any prolonged period of time. Additionally, the HPCI System is in the System Standby mode during normal plant operation and lined up for automatic actuation, so there is normally no flow through the system and the lubricating oil temperature approximates the ambient air conditions. Therefore, change in material properties and cracking due to thermal exposure are not aging effects requiring management for the synthetic rubber flexible connections of the HPCI System that are exposed to indoor air (external) or lubricating oil (internal).

Ultraviolet radiation and ozone are applicable aging mechanisms only for natural rubber components that are exposed to sources of ultraviolet radiation and ozone. The flexible connections of the HPCI System are fabricated of synthetic rubber rather than natural rubber, and synthetic rubbers have been demonstrated to have excellent resistance to ultraviolet radiation and ozone. The indoor air and lubricating oil environments of the HPCI System contain no significant sources of ultraviolet radiation and ozone. Therefore, change in material properties and cracking due to ultraviolet radiation and ozone are not aging effects requiring management for the synthetic rubber flexible connections of the HPCI System that are exposed to indoor air (external) or lubricating oil (internal).

For the elastomer components in the Primary Containment Atmosphere Circulation System and the Reactor Building HVAC System, and for the Teflon components in the Sampling System, exposure to a TID equal to or greater than 10E6 rads (externally) and to temperatures of 95°F or higher (internally and externally) during normal plant operations can be expected. Therefore, change in material properties and cracking are aging effects requiring management for the elastomer components in the Primary Containment Atmosphere Circulation and the Reactor Building HVAC systems but not in the HPCI System when exposed to indoor air (external) or ventilation (internal) environments.

Part B. As described in the response to Part A above, no material properties or aging effects are impacted by exposure of the synthetic rubber materials in the HPCI System to the lubricating oil and indoor air environments.

The material properties that could be impacted include hardening (e.g., embrittlement, decrease in elasticity) and loss of strength (e.g., elongation, loss of tensile strength, and, with exposure to ionizing radiation, swelling or melting). These properties relate to the aging effects identified in GALL for elastomers. Cracking is also identified as a potential aging effect. Each of these aging mechanisms has an established environmental threshold below which degradation is not a concern.

RAI 3.3.2.2.5.1-1:

Part A. For those elastomeric or polymeric components that are exposed to either the ventilation environment or indoor air environment and are identified as being subject to the aging effect of "changes in material properties," identify the specific material properties that could be impacted by exposure to either the ventilation environment or uncontrolled indoor air environment.

Part B. Justify, using a valid technical basis, why cracking and changes in material properties was not identified as an applicable AERM for the neoprene or fiberglass flexible connection (expansion joint) surfaces in the reactor building HVAC system that are exposed internally to the ventilation environment when these aging effects had been identified as AERMs for the analogous neoprene expansion joint surfaces in the primary containment air processing system that are exposed internally to the ventilation environment.

PPL Response:

Part A. The specific material properties that could be impacted by exposure to either the ventilation environment or uncontrolled indoor air environment are hardening (e.g., embrittlement, decrease in elasticity) and loss of strength (e.g., elongation, loss of tensile strength, and, with exposure to ionizing radiation, swelling or melting). Both types of material property changes could occur as a result of prolonged exposure to high temperature (95°F or higher), high radiation levels (equal to or greater than 10E6 rads total integrated dose (TID)), or to ultraviolet radiation or ozone.

Part B. Cracking and change in material properties were not identified as aging effects requiring management for the neoprene or fiberglass flexible connection surfaces in the Reactor Building HVAC System that are exposed internally to the ventilation environment for the following reasons:

Note that for purposes of aging management review (AMR), neoprene is the material that performs the pressure boundary function for the subject flexible connections. A braided fiberglass fabric covers the external surface of each flexible connection, but provides no pressure boundary function and is not subject to AMR.

Cracking and change in material properties of elastomers, such as neoprene, may be due to ionizing radiation, thermal exposure, or exposure to ultraviolet radiation or ozone.

Ionizing radiation is an applicable aging mechanism for elastomer components only if they are exposed to a TID equal to or greater than 10E6 rads (or 10E7 rads for natural and nitrile rubbers). The ionizing radiation levels in the ambient indoor air environment of the Reactor Building are such that the TID may exceed these limits, and therefore change in material properties and cracking due to ionizing radiation are aging effects requiring management for the neoprene components of the Reactor Building HVAC System due to exposure to the indoor air (external) environment, as shown in LRA Table 3.3.2-23. However, there are no sources of ionizing radiation within the ventilation environment of the Reactor Building HVAC System, so there is no additional contribution to the TID from the internal environment. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for the neoprene components in the Reactor Building HVAC System due to exposure to the ventilation (internal) environment.

Thermal exposure is an applicable aging mechanism for synthetic rubber components only if they are exposed for prolonged periods to a temperature of 95°F or higher. The ambient air temperature range in the HVAC equipment room and the pump rooms where the neoprene components of the Reactor Building HVAC System are located is maintained such that it will not exceed 95°F for any prolonged period of time. Also, there are no additional heat sources within the ventilation environment of the Reactor Building HVAC System that would contribute to thermal exposure for the internal surfaces. Therefore, change in material properties and cracking due to thermal exposure are not aging effects requiring management for the neoprene components in the Reactor Building HVAC System that are exposed to the ventilation (internal) environment.

Ultraviolet radiation and ozone are applicable aging mechanisms only for natural rubber components that are exposed to sources of ultraviolet radiation and ozone. The flexible connections in the Reactor Building HVAC System are fabricated of neoprene rather than natural rubber, and neoprene has been demonstrated to have excellent resistance to ultraviolet radiation and ozone. The ventilation environment of the Reactor Building HVAC System contains no sources of ultraviolet radiation or ozone. Therefore, change in material properties and cracking due to ultraviolet radiation and ozone are not aging effects requiring management for the neoprene components in the Reactor Building HVAC System that are exposed to the ventilation (internal) environment.

Note that "primary containment air processing system" is not an SSES system. However, for the neoprene components in the Primary Containment Atmosphere Circulation System, prolonged exposure to temperatures greater than 95 ° F and to a TID greater than 10E6 rads, during normal plant operations can be expected. Therefore, change in material properties and cracking are aging effects requiring management for the neoprene or flexible connection surfaces in these systems that are exposed to the ventilation (internal).

RAI 3.3.2.2.5.1-2:

The staff has noted that the applicant's "ventilation" environmental grouping and "indoor air/protected from weather" environmental grouping, as given in LRA Tables 3.0-1 or 3.0-2, cover a wide range of specific environments and environmental conditions. The staff also noted that the environmental tables did not provide sufficient evidence that the environmental conditions imposed under the ventilation environmental grouping (or the environments within the scope of this grouping) are the equivalent to those that would be imparted by exposure to an uncontrolled indoor air environment or the environment in the indoor air grouping, nor do the environmental descriptions for these groupings establish what the radiologically-induced aging thresholds and thermally-induced aging thresholds are for the specific environments that make up the ventilation environment and indoor air environment groupings or what the maximum and minimum temperatures and maximum radiation levels will be for each of the various environments that are within the scope of the ventilation and indoor air groupings.

Part A. Clarify, using a valid technical basis, why the environmental conditions for an internal ventilation environment are considered to be equivalent to the environmental conditions that are applicable to an external uncontrolled indoor air environment.

Part B. For each environment that is within the scope the "ventilation" environmental grouping or "indoor air/protected from weather" environmental grouping in the LRA, identify (and justify the basis) the radiological-induced (gamma ray) aging threshold and threshold that is used to screen polymer/elastomer components in these environments for age related degradation (including cracking, hardening, loss of strength, or other material property changes), and identify what the maximum-to-minimum temperature ranges and maximum gamma radiation levels are for these specific environments.

PPL Response:

Part A. The environmental conditions for an internal ventilation environment are, in most cases but not all, considered to be equivalent to the environmental conditions that are applicable to an external uncontrolled indoor air environment, based on the following:

As described in LRA Table 3.0-1, internal ambient environments found inside components, such as piping and tanks that are either vented or otherwise open to the ambient conditions in their location, are also included in the "ventilation" environment grouping. It is reasonable to assume that, for such components, the relevant conditions that can lead to aging, such as temperature and moisture, are the same both inside and outside the component. In these cases, the condition of the external surface is expected to be representative of the internal surface condition.

Also included in the "ventilation" environment grouping is ambient air that may be conditioned by filtering, heating, cooling, or dehumidification, or some combination thereof, in order to maintain a suitable environment for equipment operation or personnel occupancy. For components exposed internally to this environment, it is reasonable to assume that the relevant conditions that can lead to aging are generally less aggressive, or at least no more aggressive, than the ambient air to which the same components are exposed externally. In these cases, aging of the external surfaces is expected to progress at a faster rate than aging of the internal surfaces.

In both of these cases, the System Walkdown Program, which is consistent with the GALL AMP XI.M36 External Surfaces Monitoring, may be credited with aging management.

However, if the relevant conditions for aging that exist in the internal "ventilation" environment for a component are different than those that exist on the external surface of that component (i.e., "indoor air/protected from weather"), then the System Walkdown Program is not credited with aging management. For example, there may be a difference between the internal and external temperature that could result in condensation; or there may be an air-water interface where alternate wetting and drying could result in a concentration of contaminants on the surface. In these cases, a different program, such as the Cooling Units Inspection (LRA B.2.23) or the Supplemental Piping/Tank Inspection (LRA B.2.28), is credited.

Part B. For all "ventilation" and "indoor air/protected from weather" environmental groupings in the LRA, the relevant conditions (thresholds) for aging of polymer/elastomer components are as follows:

- For thermal aging, prolonged exposure to a temperature equal to or greater than 95°F.
- For ionizing radiation, exposure to total integrated dose equal to or greater than 10E6 rads (or equal to or greater than 10E7 rads for natural and nitrile rubbers).
- For ultraviolet radiation and ozone, which is applicable only to natural rubber, prolonged exposure at any level in the presence of oxygen.

These thresholds are based on extensive industry research, as documented in relevant EPRI technical reports, such as the mechanical and structural "Tools."

The minimum and maximum normal operating temperature and the maximum total integrated dose for specific buildings / areas within the plant and within the scope of license renewal are as follows:

Building / Area	**Normal Operating Temperature Range**		**Maximum Total Integrated Dose (rads)**	
	Minimum	**Maximum**[1]	**40-Year**	**60-Year (Projected)**
Reactor Building	40°F	130°F	1.8x10E8	2.7x10E8
Primary Containment	90°F	150°F	6.5x10E9	9.8x10E9
ESSW Pumphouse	40°F	104°F	1.8x10E2	2.7x10E2
Circulating Water Pumphouse and Water Treatment Building	40°F	104°F	2.0x10E2	3.0x10E2
Control Structure	40°F	104°F	8.8x10E2	1.3x10E3
Diesel Generator Buildings	72°F	104°F	1.8x10E2	2.7x10E2
Turbine Building	None Specified	120°F	5.3x10E6	8.0x10E6

[1] The maximum normal operating temperature for each building / area specified represents a hot spot or a design consideration for HVAC. However, these are all controlled environments where the temperature is not expected to equal or exceed 95 deg F for a prolonged period of time.

RAI 3.3.2.2.5.1-3:

Part A. Provide your basis why PPL has not identified any applicable AERM for the following auxiliary system AMR component/material/environmental grouping combinations that were identified in the application as being aligned either to the GALL AMR VII.F1-7, VII.F2-7, VII.F3-7, or VII.F4-6:

(1) Silicone rubber heat exchanger tube plugs in the diesel generator intake exhaust systems under exposure to the ventilation environment,

(2) elastomeric (synthetic rubber) flexible connections (hoses) in the diesel generator system, HPCI system, and fire protection system under external exposure to uncontrolled indoor air,

(3) neoprene flexible connections in the diesel generator buildings HVAC system that are exposed internally to the ventilation environment and externally to the uncontrolled indoor air environment,

(4) neoprene/asbestos flexible connections in the diesel generator buildings HVAC system and the control structure HVAC system that are exposed internally to the ventilation environment and externally to the uncontrolled indoor air environment, and

(5) neoprene/fiberglass flexible connections in the diesel generator buildings HVAC system and the control structure HVAC system that are exposed internally to the ventilation environment and externally to the uncontrolled indoor air environment.

Part B. In RAI 3.3.2.2.5.1-2, the staff asked the applicant to provide supplemental information on the radiological conditions and temperature ranges for each of the environments that are within the scope PPL's "ventilation" and "indoor air/protected from weather" environmental groupings. Taking into account your response to RAI 3.3.2.2.5.1-2, Parts A and B, for each component/material/environmental grouping combination mentioned in Part A of this RAI, identify the specific environment that the components are exposed to (for example, the "ventilation" and "indoor air/protected from weather" environmental grouping each appear to be made up and bound various environments and environmental conditions).

PPL Response:

Part A. PPL has not identified any aging effects requiring management for the component/material/environmental groupings that are listed in RAI 3.3.2.2.5.1-3, Part A, for the following reasons:

The applicable aging effects for elastomers are change in material properties and cracking. Change in material properties and cracking of elastomers may be due to ionizing radiation, thermal exposure, or exposure to ultraviolet radiation or ozone.

Ionizing radiation is an applicable aging mechanism for elastomer components only if they are exposed to a total integrated dose (TID) equal to or greater than 10E6 rads (or 10E7 rads for natural and nitrile rubbers). However, the aging management review determined that, for all of the components identified in RAI 3.3.2.2.5.1-3, ionizing radiation levels in the areas of the plant in which the subject components are located are such that the TID over a 60-year period, which includes the period of extended operation, will not equal or exceed 10E6 rads. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for these components.

Thermal exposure is an applicable aging mechanism for elastomer components only if they are exposed for prolonged periods to a temperature equal to or greater than 95°F. The aging management review determined that the normal operating temperature to which these components are exposed will not exceed 95°F for any prolonged period of time. Therefore, change in material properties and cracking due to thermal exposure are not aging effects requiring management for these components.

Ultraviolet radiation and ozone are applicable aging mechanisms only for natural rubber components that are exposed to sources of ultraviolet radiation and ozone. None of the subject components are fabricated of natural rubber, and neoprene, silicone rubber, and synthetic rubber have been demonstrated to have excellent resistance to ultraviolet radiation and ozone. The indoor air and ventilation environments for the subject components contain no significant sources of ultraviolet radiation and ozone. Therefore, change in material properties and cracking due to ultraviolet radiation and ozone are not aging effects requiring management for these components.

Part B. The specific environment for each component/material/environment grouping described in RAI 3.3.2.2.5.1-3, Part A, is as follows:

Part A Grouping[1]	Building / Area
(1)	Diesel Generator Buildings
(2)	Diesel Generator Buildings
	Circulating Water Pumphouse and Water Treatment Building
(3)	Diesel Generator Buildings
(4)	Diesel Generator Buildings
	Control Structure
(5)	Diesel Generator Buildings
	Control Structure

[1] Note that there are no elastomer flexible connections in LRA Table 3.2.2-4 for the High Pressure Coolant Injection System that are aligned to GALL items VII.F1-7, VII.F2-7, VII.F3-7, or VII.F4-6, as indicated in Part A Item (2) of the RAI.

RAI 3.3.2.2.5.2-1:

Provide your basis for concluding that there are not any AERM for the silicone tube plugs in the diesel generator intake/exhaust system that are exposed to treated water. In particular, provide your basis why these heat exchanger tube plugs are not expected to degrade (i.e., harden or lose strength) under prolonged exposure to the treated water environment over the course of the period of extend operation.

PPL Response:

PPL has not identified any aging effects requiring management for the silicone tube plugs in the Diesel Generators System (Intake/Exhaust) that are exposed to treated water for the following reasons:

The applicable aging effects for elastomers are change in material properties and cracking. Change in material properties and cracking of elastomers, such as silicone, may be due to ionizing radiation, thermal exposure, or exposure to ultraviolet radiation or ozone.

Ionizing radiation is an applicable aging mechanism for silicone components only if the total integrated dose (TID) is equal to or greater than 10E6 rads. The silicone tube plugs in the Diesel Generators System (Intake/Exhaust) are installed in the diesel air intake intercooler heating cores. The intercoolers are located in the Diesel Generator Buildings. The Diesel Generator Buildings are not defined as areas where harsh environments can potentially occur, and the TID, even when projected to 60 years, is well below 10E6 rads. Also, during normal plant operation, the silicone tube plugs are exposed to a treated water environment that is not expected to contain or to release any measurable ionizing radiation. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for the silicone tube plugs in the Diesel Generators System (Intake/Exhaust) that are exposed to treated water.

Thermal exposure is an applicable aging mechanism for silicone components only if they are exposed for prolonged periods to a temperature equal to or greater than 95°F. To ensure proper diesel generator operation, Diesel Generator Rooms A, B, C and D are individually ventilated and heated to maintain a temperature in the range of approximately 85°F to 95°F. Also, during normal plant operation, the diesel generators are in a standby mode, so the silicone tube plugs are exposed to a treated water temperature that is expected to be approximately the same as the ambient air temperature. Therefore, change in material properties and cracking due to thermal exposure are not aging effects requiring management for the silicone tube plugs in the Diesel Generators System (Intake/Exhaust) that are exposed to treated water.

Ultraviolet radiation and ozone are applicable aging mechanisms only for natural rubber components that are exposed to sources of ultraviolet radiation and ozone. The tube plugs are fabricated of silicone rather than natural rubber, and silicone has been demonstrated to have excellent resistance to ultraviolet radiation and ozone. The treated water environment associated with the Diesel Generator intake/exhaust system contains no sources of ultraviolet radiation or ozone. Therefore, change in material properties and cracking due to ultraviolet radiation and ozone are not aging effects requiring management for the silicone tube plugs in the Diesel Generators System (Intake/Exhaust) that are exposed to treated water.

RAI 3.3.2.2.13-1:

The staff has noted that in LRA Section 3.1.2.2.13, PPL uses the following basis to establish that loss of material due to wear is not considered to be an AERM for elastomeric seals and components in the control structure, diesel generator building, Engineered Safeguards Service Water (ESSW) pumphouse, and reactor building HVAC systems and in primary containment atmosphere circulation system:

> "Loss of material due to wear is the result of relative motion between two surfaces in contact. However, wear occurs during the performance of an active function; as a result of improper design, application or operation; or to a very small degree with insignificant consequences. Therefore, loss of material due to wear is not an aging effect requiring management for elastomers exposed to air indoor uncontrolled at SSES."

The fact that wear is an active aging mechanism does not provide a valid reason to conclude that passive long-lived elastomeric HVAC seals or components in these auxiliary HVAC systems would not be subject to potential loss of material due to wear. In the RAI, the staff asked the applicant to provide a valid basis why loss of material due to wear is not considered to be an AERM for the elastomeric seals and components in the control structure HVAC systems, diesel generator building HVAC systems, ESSW pumphouse HVAC system, primary containment atmosphere circulation system, or reactor building HVAC system.

PPL Response:

The basis provided in LRA Section 3.1.2.2.13 to conclude that loss of material due to wear is not an aging effect requiring management for elastomer seals and components in the Control Structure, Diesel Generator Buildings, ESSW Pumphouse, and Reactor Building HVAC systems and in the Primary Containment Atmosphere Circulation System provided three possible justifications that have been documented in industry guidance on the aging of elastomers.

The basis upon which PPL concluded that loss of material due to wear is not an aging effect requiring management for elastomer seals and components in the Control Structure, Diesel Generator Buildings, ESSW Pumphouse, and Reactor Building HVAC systems and in the Primary Containment Atmosphere Circulation System is that:

- the elastomer seals and components were selected based on their suitability for the service in which they would be applied, i.e., they were properly designed;
- the elastomer seals and components were properly applied and installed, i.e., within allowable pre-compression and offset limits, thus preventing significant relative motion between the contacting surfaces; and,
- the systems in which the elastomer seals and components are installed are operated in accordance with procedures that have been developed based on standard industry good practices, thus preventing excessive vibration and unintended component movements.

Flexible connections are used in applications where some movement between the joined piping, ductwork, and components is expected to occur. However, as indicated above, the flexible connections are securely attached to the joined components such that there is no relative movement between the connection of the flexible connection and the component. The flexible connection is designed to accommodate relative movements, however proper design and installation ensures that the flexible connection does not make contact with itself or with other nearby components. Therefore, there is no relative motion expected between contacting surfaces and wear is not an aging effect requiring management.

RAI 3.3.2.3-1:

The staff verified that the LRA Section 3.3 includes plant-specific AMR items refer to the following system-elastomeric material-environment combinations:

- silicone plugs in diesel fuel intake and exhaust system heat exchangers under exposure to externally to a ventilation environment and internally to either a treated water environment or a raw water environment
- elastomeric flexible connection (synthetic rubber hoses) in the diesel fuel oil and diesel generator lubricating oil systems under internal exposure to either diesel fuel oil or lubricating oil and external exposure to indoor air
- sight glasses in the reactor building HVAC system and the control structure chilled water system under exposure to the air gas environment (including Freon)
- glass lining in the domestic water system tank under exposure to the raw water environment

- flexible connections (ductwork) made of neoprene, neoprene/asbestos, or neoprene/ fiberglass in the reactor building HVAC, control structure HVAC or diesel generator building HVAC systems under internal exposure to the ventilation environment and external exposure to the indoor air environment
- plastic (Lucite) level gauges in the diesel generator lubricating oil system under internal exposure to the ventilation environment and external exposure to the indoor air environment
- plastic (polycarbonate) filters in the diesel generator starting system under internal exposure to the air-gas environment and external exposure to the indoor air environment
- synthetic rubber flexible connections (hoses) in the fire protection system under internal exposure to either raw water or fuel oil and external exposure to indoor air
- Teflon components (i.e. piping or flexible connections) in the fire protection system and sampling system under internal exposure to either raw water or treated water and external exposure to indoor air
- butyl rubber accumulators in the SLC systems that are exposed internally to a nitrogen air gas environment and externally to treated water

Part A. Taking into account information that you have provided in response to RAI 3.3.2.2.5.1-1, RAI 3.3.2.2.5.1-2, and RAI 3.3.2.2.5.1-3, and in RAI 3.3.2.2.5.2-1, and in RAI 3.3.2.2.13-1, provide your basis why PPL has not identified any AERMs for these system-material-environment combinations when cracking and changes in materials had been identified as applicable aging effects for: (1) neoprene and rubber components in the primary containment atmosphere circulation system under exposure to indoor air and to ventilation air, (2) neoprene/fiberglass components in the reactor building HVAC system under exposure to indoor air and to ventilation air, and (3) for Teflon piping in the sampling system (changes in material properties only) under exposure to indoor air.

Part B. Identify those material properties and aging effects that could be impacted by exposure of these materials to treated water, raw water, fuel oil, lubricating oil, ventilation air, indoor air, and air-gas (including Freon) environments.

Part C. Identify the AMP or AMPs that will be credited for aging management if PPL does identify that are applicable AERMs for any of these system-material-environmental combinations (as listed in bullets for this RAI).

<u>PPL Response</u>:

Part A. PPL has not identified any aging effects requiring management for the system-material-environment combinations listed in RAI 3.3.2.3-1 for the following reasons:

Note that for purposes of aging management review (AMR), neoprene is the material that performs the pressure boundary function for the subject flexible connections identified as neoprene/asbestos and neoprene/fiberglass. A braided asbestos or fiberglass fabric covers the external surface of each flexible connection, but provides no pressure boundary function and is not subject to AMR.

The applicable aging effects for elastomers (including butyl rubber, synthetic rubber, neoprene, and silicone) are change in material properties and cracking. Change in material properties and cracking of elastomers may be due to ionizing radiation, thermal exposure, or exposure to ultraviolet radiation or ozone.

Ionizing radiation is an applicable aging mechanism for elastomer components only if they are exposed to a total integrated dose (TID) equal to or greater than 10E6 rads (or 10E7 rads for natural and nitrile rubbers). However, the aging management review determined that, for all of the elastomer components identified in RAI 3.3.2.3-1, except for flexible connections in the Reactor Building HVAC System identified in the fifth bullet, ionizing radiation levels in those areas of the plant are such that the TID over a 60-year period, which includes the period of extended operation, will not equal or exceed 10E6 rads. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for these components, except for those in the Reactor Building HVAC System that are exposed to the indoor air environment of the Reactor Building (LRA Table 3.3.2-23).

Thermal exposure is an applicable aging mechanism for elastomer components only if they are exposed for prolonged periods to a temperature of 95°F or higher. The aging management review determined that the normal operating temperature to which these components are exposed will not exceed 95°F for any prolonged period of time. Therefore, change in material properties and cracking due to thermal exposure are not aging effects requiring management for these components.

Ultraviolet radiation and ozone are applicable aging mechanisms only for natural rubber components that are exposed to sources of ultraviolet radiation and ozone. There are no natural rubber components identified in RAI 3.3.2.3-1. Therefore, change in material properties and cracking due to ultraviolet radiation and ozone are not aging effects requiring management.

The only applicable aging effect for Teflon is change in material properties. Change in material properties of Teflon may be due to exposure to gamma radiation. Thermal exposure and exposure to ultraviolet radiation or ozone are not applicable aging mechanisms for Teflon.

Gamma radiation is an applicable aging mechanism for Teflon components only if the total integrated dose (TID) is equal to or greater than 10E4 rads. The Teflon components in the Fire Protection System are located in the Circulating Water Pumphouse, an area of the plant where ionizing radiation levels are such that the TID over a 60-year period, which includes the period of extended operation, will not equal or exceed 10E3 rads. Also, there are no sources of gamma radiation expected to exist in the raw water of the Fire Protection System or the treated water environment of the Sampling System. Therefore, change in material properties and cracking due to ionizing radiation are not aging effects requiring management for these components, except for those in the Sampling System that are exposed to the indoor air environment of the Reactor Building (LRA Table 3.3.2-27).

For the elastomer components in the Primary Containment Atmosphere Circulation System and the Reactor Building HVAC System, and for the Teflon components in the Sampling System, exposure to TID greater than 10E6 rads and to temperatures greater than 95°F during normal plant operations can be expected. Therefore, change in material properties and cracking are aging effects requiring management for the in these systems that are exposed to the indoor air (external) environment and the ventilation (internal) environment.

The relevant conditions that could result in aging degradation of glass are high temperature water, and/or the presence of hydrofluoric acid or caustic alkalis. Hydrofluoric acid and caustic alkalis are not expected to exist in the air-gas (including Freon) environments of the Reactor Building HVAC System or the Control Structure Chilled Water System; nor in the raw water environment of the Domestic Water System. When hot water attacks glass, it is not dissolved in the usual sense but is hydrolytically decomposed. Resistance to water varies from excellent to poor depending on the composition of the glass. Furthermore, glass-lined steel combines the corrosion resistance of glass with the strength of steel, making it useful for equipment operating at elevated temperature and pressure. Glass-lined steel has excellent resistance to corrosion over a wide range of pH and environments. As such, it is expected that the glass lining for the water heater tank is properly designed and selected for the service in which it is used. Therefore, there are no aging effects requiring management for the subject glass components in the Reactor Building HVAC System, the Control Structure Chilled Water System, and the Domestic Water System.

Degradation of plastic materials is considered a design issue. Plastic is either completely resistant to the environment to which it is exposed, or it deteriorates. Acceptability for the use of plastics in any particular environment is a design-driven criterion, and once the appropriate material is chosen, the component will have no aging effects that require management. That is, the occurrence of any aging effects is considered a design deficiency that will be detected and corrected within the current license period. Therefore, based on a review of industry operating experience and the expectation of proper design and application of the material, aging of plastics is not considered to require further evaluation for license renewal.

Part B. Degradation of an elastomer is not significantly impacted by the type of environment to which it is exposed; i.e., elastomers are selected for service in a particular environment based on their suitability for that environment, including their resistance to chemical attack. Therefore, regardless of the particular environment to which they are exposed, aging of elastomers occurs as a result of change in material properties and cracking, and is evaluated based on the relevant conditions described in the Part A response above.

The specific aging effects are cracking for elastomers, and change in material properties for elastomers and Teflon. The specific material properties that could be impacted by exposure to treated water, raw water, fuel oil, lubricating oil, ventilation air, indoor air, and air-gas (including Freon) environments are hardening (e.g., embrittlement, decrease in elasticity) and loss of strength (e.g., elongation, loss of tensile strength, and, with exposure to ionizing radiation, swelling or melting). Hardening and loss of strength could occur as a result of prolonged exposure to high temperature, high radiation levels, or to ultraviolet radiation or ozone.

Part C. There are no aging effects requiring management for the system-material-environment combinations listed in RAI 3.3.2.3-1, except for those that have already been identified in the LRA as noted in the response to Part B.

<u>RAI 3.3.2.3-2</u>:

The staff is concerned that the Freon environment for the glass sight gauges in the reactor building HVAC system might create sufficiently cold environments for the glass material, and that as a result of this environment, fracture toughness of the material may be impacted. Thus, the staff was concerned that the Freon environment might impact the flaw tolerance of the glass material used to fabricate these sight gauges and the crack size that material may tolerate may be reduced. Provide your basis why reduction of fracture toughness and cracking are not be applicable AERMs for the surfaces of glass sight gauges in the reactor building HVAC system under exposure to an air – gas (Freon) environment.

<u>PPL Response</u>:

Reduction of fracture toughness and cracking are not aging effects requiring management for the glass sight gauges in the Reactor Building HVAC System under exposure to the air-gas (Freon) environment for the following reasons.

The only relevant conditions that could result in aging degradation (such as cracking) of glass, as identified by industry operating experience, and by research conducted by the Electric Power Research Institute, are exposure to high-temperature water, and/or exposure to hydrofluoric acid or caustic alkalis. High-temperature water, hydrofluoric acid, and caustic alkalis are not expected to exist in the air-gas (Freon) environment of the Reactor Building HVAC System.

Exposure to low temperature has not been identified as a relevant condition that could result in aging degradation of glass. Also, reduction in fracture toughness has not been identified as an applicable aging effect for glass, which is by definition a brittle material when subject to impact.

Additionally, the coldest part of the refrigeration cycle, expansion, is typically in the range of approximately 30°F to 40°F, which is not exceptionally cold. The subject glass sight gauges, however, are located between the components of compression and expansion cycles, where the temperature is typically in the range of approximately 95°F to 110°F.

Therefore, there are no aging effects requiring management for the subject glass sight gauges in the Reactor Building HVAC System.

RAI 3.4.2.3-1:

The staff has noted that in the LRA, appears take in inconsistent approach to aging management of elastomeric, rubber, and polymeric components in the application, because in some AMRs for these types of materials the applicant had identified that cracking and changes in material properties were applicable AERMs, whereas in other AMRs the applicant concluded that AERMs were not applicable to the components. The staff seeks consolidation of PPL's approach to management of aging in the elastomeric, rubber, and polymeric steam and power conversion system components with the aging management approach taken for these type of components in the auxiliary systems.

Part A. Provide your basis why PPL has not identified any AERMs for rubber component surfaces in the containment and air removal (CAR) system that are exposed to the treated water and the indoor air environments when cracking and changes in materials had been identified as applicable aging effects for: (1) neoprene and rubber components in the primary containment atmosphere circulation system under exposure to indoor air and to ventilation air, (2) neoprene/fiberglass components in the reactor building HVAC system under exposure to indoor air and to ventilation air, and (3) for Teflon piping in the sampling system (changes in material properties only) under exposure to indoor air.

Part B. Identify the rubber material that is used to fabricate the flexible expansion joints in the CAR systems and identify those material properties and aging effects that could be impacted by exposure of these rubber materials to the treated water and indoor air environments.

PPL Response:

Part A. Note that the containment and air removal (CAR) system is not one of the identified SSES steam and power conversion systems. The steam and power conversion system for which rubber is identified as an applicable material is the Condenser and Air Removal System, LRA Table 3.4.2-4. The following response is written based on the understanding that RAI 3.4.2.3-1 was meant to address the Condenser and Air Removal System.

There were no aging effects identified as requiring management because no aging effects were considered to be of a significance that would prevent the intended function in this application of maintaining the ICTM volume (isolated condenser treatment method) as defined in LRA Table 2.0-1 and discussed in LRA Section 2.3.4.4.

As a result of a further evaluation of the aging management review (AMR) for the Condenser and Air Removal System, it was determined that the rubber expansion joints (condenser boots) are subject to replacement on a specified time period in accordance with plant preventive maintenance activities. The expansion joints are, therefore, short-lived components and are not subject to aging management review.

The LRA is amended as follows to make the necessary changes associated with the above conclusion.

- Section 2.3.4.4 (on LRA page 2.3-129) is revised by addition (***bold italics***) and by deletion (~~strikethrough~~).

Components Subject to AMR

The flexible connections (expansion joints) are short-lived components and not subject to aging management review.

Table 2.3.4-4 lists the component types that require aging management review and their intended functions.

Table 3.4.2-4, Aging Management Review Results – Condenser and Air Removal System, provides the results of the aging management review.

Table 2.3.4-4
Condenser and Air Removal System
Components Subject to Aging Management Review

Component Type	**Intended Function (as defined in Table 2.0-1)**
Bolting	ICTM Volume Structural Integrity
Condensers (shell, inlet/outlet water boxes, tubes, tubesheet, tube plugs)	ICTM Volume
Condensers (shell) – 1(2)E108A	ICTM Volume Structural Integrity
~~Flexible connections (expansion joints)~~	~~ICTM Volume~~
Piping	ICTM Volume

➢ Section 3.4.2.1.4 (on LRA page 3.4-5) is revised by deletion (~~strikethrough~~).

3.4.2.1.4 Condenser and Air Removal System

Materials

The materials of construction for the Condenser and Air Removal System components are:

- Carbon Steel
- ~~Rubber~~
- Stainless Steel

- The following line item (on LRA page 3.4-48) is revised by deletion (~~strikethrough~~).

Table 3.4.2-4 Aging Management Review Results - Condenser and Air Removal System

Component / Commodity	Intended Function	Material	Environment	Aging Effect Requiring Management	Aging Management Programs	NUREG-1801 Volume 2 Item	Table 1 Item	Notes
~~Flexible Connections (Expansion Joints)~~	~~ICTM Volume~~	~~Rubber~~	~~Treated Water (Internal)~~	~~None Identified~~	~~None Required~~	~~N/A~~	~~N/A~~	~~I, 0406~~
			~~Indoor Air (External)~~	~~None Identified~~	~~None Required~~	~~N/A~~	~~N/A~~	~~I, 0406~~

Part B. The materials that are used to fabricate acceptable replacements for the flexible expansion joints (condenser boots) in the Condenser and Air Removal System are neoprene-impregnated nylon, or nitrile-impregnated nylon.

The material properties that could be impacted include hardening (loss of flexibility) and loss of strength. These properties relate to the aging effects identified in GALL for elastomers. Cracking is also identified as a potential aging effect. Each of these aging mechanisms has an established environmental threshold below which degradation is not a concern.

As described in the response to Part A above, these flexible expansion joints are not subject to aging management. Therefore, there are no material properties or aging effects that require evaluation as a result of exposure of these materials to the treated water and indoor air environments of the Condenser and Air Removal System.