December 16, 2004

10 CFR 54

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Washington, D.C. 20555-0001

Gentlemen:

In the Matter of	)	Docket Nos. 50-259
Tennessee Valley Authority	)	50-260
		50-296

BROWNS FERRY NUCLEAR PLANT (BFN) - UNITS 1, 2, AND 3 LICENSE RENEWAL APPLICATION - MECHANICAL SYSTEMS SECTIONS 3.2 AND 3.4 - RESPONSE TO NRC REQUEST FOR ADDITONAL INFORMATION (RAI) (TAC NOS. MC1704, MC1705, AND MC1706)

By letter dated December 31, 2003, TVA submitted, for NRC review, an application pursuant to 10 CFR 54, to renew the operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2, and 3. As part of its review of TVA's license renewal application, the NRC staff, by letter dated November 18, 2004, identified areas where additional information is needed to complete its review.

The specific areas requiring a request for additional information (RAI) are related to the aging management of Sections 3.2 and 3.4 of the License Renewal Application (LRA).

The enclosure to this letter contains the specific NRC requests for additional information and the corresponding TVA response.

If you have any questions regarding this information, please contact Ken Brune, Browns Ferry License Renewal Project Manager, at (423) 751-8421.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 16th day of December, 2004.

Sincerely,

Original signed by

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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3
LICENSE RENEWAL APPLICATION (LRA),

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI),
RELATED TO MECHANICAL SYSTEMS SECTION 3.2 AND 3.4

(SEE ATTACHED)

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNITS 1, 2, AND 3
LICENSE RENEWAL APPLICATION (LRA),

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION (RAI), RELATED TO MECHANICAL SYSTEMS SECTION 3.2 AND 3.4

By letter dated December 31, 2003, the Tennessee Valley Authority (TVA) submitted, for NRC review, an application pursuant to 10 CFR 54, to renew the operating licenses for the Browns Ferry Nuclear Plant, Units 1, 2, and 3. As part of its review of TVA's license renewal application, the NRC staff, by letter dated November 18, 2004, identified areas where additional information is needed to complete its review.

The specific areas requiring a request for additional information (RAIs) are related to the aging management of Sections 3.2 and 3.4 of the License Renewal Application (LRA).

Listed below are the specific NRC requests for additional information and the corresponding TVA responses.

Section 3.2 Engineered Safety Features Systems

NRC RAI 3.2-1

In LRA Tables 3.2.2.1 through 3.2.2.7, carbon and low alloy steel bolting in an inside air (external) or outside air (external) environment is not identified with any aging effects requiring management. The applicant indicated that this is because BFN do not use high yield strength bolting. Discuss the specific material grading used for the bolting in each of the associated systems, and justify the basis for concluding that crack initiation/growth due to SCC is not a concern for the bolting during the period of extended operation.

TVA RESPONSE TO RAI 3.2-1

In LRA Tables 3.2.2.1 through 3.2.2.7, carbon and low alloy steel bolting in an inside air (external) or outside air (external) environment has a loss of material aging effect identified. The identified aging management program is the Bolting Integrity Program. As noted, a cracking aging effect is not identified because high yield bolting materials (yield strength above 150 ksi) were not identified and plant operating experience does not indicate an adverse history of bolt cracking.

Stress corrosion cracking (SCC) of bolted closures and fasteners is a condition of high yield strength bolting material where a fastener that is statically loaded well below its yield strength can experience sudden failure. SCC occurs through the combination of high stress (both applied and residual tensile stresses), a corrosive environment, and a susceptible material. SCC of high yield strength bolted closures in BWRs requires a corrosive environment typically attributed to leakage of pressure boundary joints or exposure to wetted ambient environments (indoor, outdoor, buried and submerged) and the use of thread lubricant containing MoS_2 (molybdenum disulfide).

Potentially susceptible mechanical bolting materials include alloy steels (ASTM A354 Gr BD, A540 and A574) and high yield strength heat-treated alloy steels (heat-treated 4130, 4140 and 4340 material). High yield strength heat-treated alloy steel bolting materials are not specified for piping flanged connections at BFN. High strength bolting of vendor supplied equipment has not been identified for mechanical components (such as pump casing studs or valve body/bonnet studs) where the material specifications are available. A review of the BFN operating experience (PERs and WOs) did not identify any instances where mechanical component failure was attributable to SCC of high strength bolting. The use of MoS_2 thread lubricant is not allowed by site and engineering procedures. Therefore, any maintenance on this mechanical equipment would result in the use of non-MoS_2 thread lubricant. Loss of bolting function due to SCC of bolted joints of vendor-supplied mechanical equipment is not expected and no aging management is required for the period of extended operation.

NRC RAI 3.2-2

In LRA Tables 3.2.2.1 through 3.2.2.4, 3.2.2.6, and 3.2.2.7, nickel alloy bolting and copper alloy fittings, heat exchangers, tubing, and valves in an inside air (external) environment are not identified with any aging effects requiring management. The applicant stated, "There are no applicable aging effects for this material/environment combination. This is consistent with industry guidance." Provide a detailed discussion of the air environment involved, and justify the basis for concluding that there are no aging effects requiring management under such material/environment combinations. Provide a summary description of the stated industry guidance.

TVA RESPONSE TO RAI 3.2-2

Nickel-alloy bolting identified in Table 3.2.2.1 is used in the Containment Isolation System (System 64). The sheltered environment (inside air) precludes the presence of sufficient moisture to promote corrosion sufficient to degrade the bolting function. The nickel-alloy bolting in the Containment Isolation System was evaluated for wear and no applicable wear mechanism was identified for non-RCPB components. Therefore, wear is not an aging mechanism that requires management for the period of extended operation for the Containment Isolation System. Nickel-alloy bolting, similar to stainless steel bolting, is subject to cracking under severe environmental conditions such as high temperature and being buried or submerged (potentially, depending on type of external water). Nickel-alloy bolting in the Containment Isolation System is not subject to this severe environment; therefore, cracking was not identified.

The copper alloy components exposed to an inside air (external) environment were evaluated individually to determine where condensation or periodic wetting could occur. The identified aging effects/mechanisms were then determined based on the particular copper alloy present and whether condensation or periodic wetting could occur. Based on this evaluation, there were no instances where copper alloys components with > 15% Zn were subjected to an aggressive environment or condensation/periodic wetting. Therefore, no aging effects that require management during the period of extended operation were identified for the copper alloy components in the subject tables. A summary description of the industry guidance (i.e. when industry guidance is referenced in this set of RAIs it comes from EPRI Technical Report 1003056, “Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools”) for copper alloys is provided in the following table:

Aging Effect/Mechanism Determination for Copper Alloys		
Copper Alloy	Non-wetted environment	Wetted environment
Copper alloy (<15% Zn)	No aging effects	• MIC if there is a potential source of MIC microbes. • Galvanic corrosion if there is contact with a metal higher in the galvanic series.

Aging Effect/Mechanism Determination for Copper Alloys		
Copper Alloy	Non-wetted environment	Wetted environment
Copper alloy (>15% Zn)	No aging effects	• Selective leaching • Crevice corrosion, pitting corrosion, and stress corrosion cracking if there is a mechanism / potential for concentrating contaminates. • MIC if there is a potential source of MIC microbes. • Galvanic corrosion if there is contact with a metal higher in the galvanic series.

NRC RAI 3.2-3

In LRA Table 3.2.2.1, carbon and low alloy steel valves in an treated water (internal) environment are not identified with any aging effects requiring management. The staff noted that the component, material and environment combination for this component is similar to that identified in NUREG-1801, Item V.C.1-a, which recommends a plant-specific aging management program to be evaluated for the identified aging effects. Explain why the aging effects identified in NUREG-1801, such as loss of material due to general, pitting, and crevice corrosion, are not applicable to these components.

TVA RESPONSE TO RAI 3.2-3

The reason for the line entries that indicate no aging effects is an attempt to ensure completeness of GALL comparison. For carbon and low alloy steel valves in a treated water environment, rows 78, 79, and 80 of BFN LRA Table 3.2.2.1 address the applicable aging mechanisms. The applicable GALL Volume 2 line item was determined to be V.C.1-a. GALL Volume 2 line item V.C.1-a lists five aging effects: general, pitting, crevice, microbiologically influenced corrosion, and biofouling. For a treated water environment, the BFN aging management review determined that microbiologically influenced corrosion and biofouling did not require management for the period of extended operation. However, the BFN aging management review determined that in addition to the aging mechanisms identified in the GALL, galvanic corrosion was also applicable. This was documented in the aging management review as:

- Galvanic corrosion – Yes
- General corrosion – Yes
- Pitting corrosion – Yes
- Crevice corrosion – Yes
- Microbiologically influenced corrosion – No
- Biofouling – No

The first aging mechanism is documented in row 78 with notes H and 3. The next three aging mechanisms, which are consistent with GALL, form the basis for row 80 of BFN LRA Table 3.2.2.1. The last two aging mechanisms are documented in row 79 of BFN LRA Table 3.2.2.1 as no aging effect with Note 5 identified. This reference to Note 5 is incorrect and the correct reference is Note 4. Note 4 states, "Based on system design and operating history, MIC and biofouling were determined to be not applicable to the treated water portions of this system."

NRC RAI 3.2-4

In LRA Table 3.2.2.3, elastomer flexible connectors in an air/gas (internal) environment are not identified with any aging effects requiring management. The applicant stated, "There are no applicable aging effects for this material/environment combination. This is consistent with industry guidance." Provide a detailed discussion of the air/gas (internal) environment involved, and justify the basis for concluding that there are no aging effects requiring management under such material/environment combinations. Provide a summary description of the stated industry guidance.

TVA RESPONSE TO RAI 3.2-4

This section addresses the Rubber Fabric Reinforced (Elastomer) flexible connectors upstream and down stream of the gland seal condenser blower (gland exhauster) in an air/gas environment.

Per industry guidance, the aging effects that are applicable to elastomer include material property changes and cracking. These effects are caused by exposure to ultraviolet radiation, oxygen, ozone, heat, and radiation. In LRA Table 3.2.2.3, the elastomer degradation due to ultraviolet radiation, thermal exposure, and ionizing radiation are not identified for the following reasons:

Rubber is decomposed by exposure to ultraviolet radiation. Ultraviolet radiation includes solar radiation and ultraviolet or fluorescent lamps. Rubber may crack when exposed to air and sunlight due mainly to reaction with ozone. The ultraviolet radiation to the internal surfaces of the components is negligible and degradation from this mechanism is not significant. Therefore, cracking due to ultraviolet radiation and ozone is not an applicable aging effect for internal environments of these rubber components. The LRA does identify elastomer degradation due to ultraviolet radiation and ozone for the external surfaces of these components.

Maximum temperature rating for rubber is 130°F per industry guidance. During normal operation, the temperature of the flexible connectors is significantly less than 130°F; therefore, degradation from thermal exposure is not identified as an aging mechanism requiring management for the period of extended operation.

The dose threshold for radiation degradation of rubber is 10^7 Rads. The ionizing radiation the flexible connectors will receive is negligible (much less than 10^7 rads); therefore, degradation from ionizing radiation is not identified as an aging mechanism requiring management for the period of extended operation.

NRC RAI 3.2-5

In LRA Table 3.2.2.5, aluminum alloy fittings in a treated water (internal) environment are identified as being susceptible to crack initiation/growth due to SCC and loss of material due to crevice and pitting corrosion. Explain why loss of material due to general and galvanic corrosion is not identified as a potential aging effect to be managed during the period of extended operation. Also explain how Chemistry Control Program, with association of One-Time Inspection Program, is used to manage the identified aging effects under the above components/material/environment combinations.

TVA RESPONSE TO RAI 3.2-5

Per industry guidance, aluminum and aluminum-based alloys in a treated water environment are not susceptible to loss of material due to general corrosion.

Loss of material due to galvanic corrosion occurs when materials with different electrochemical potentials are in contact in the presence of a corrosive environment. Anodic metals like aluminum will preferentially corrode when coupled with most metals (such as copper, stainless and carbon steels) in an electrolytically conductive environment. The aluminum fittings in Table 3.2.2.5 are the flanges off the 24" diameter condensate supply header within the Core Spray System. A rubber electrically insulating gasket is used to separate the aluminum flanges from more cathodic materials. Therefore, galvanic corrosion is not a concern for aluminum fittings in a treated water environment for the Core Spray System.

The main objective of the Chemistry Control Program is to minimize loss of material due to general, crevice, and pitting corrosion and crack initiation and growth caused by stress corrosion cracking. Corrosion and cracking of aluminum alloys in treated water is managed by maintaining oxygen, chlorides, and sulfates within the limits of the Chemistry Control Program. The specific chemistry limits are the same as the limits used to manage aging of carbon/low alloy and stainless steel components in a treated water environment. The use of the Chemistry Control Program is consistent with industry practice as identified in our past precedence review. The One-Time Inspection Program is used to verify the Chemistry Control Program's effectiveness.

NRC RAI 3.2-6

In LRA Table 3.2.2.5, polymer tubing in an air/gas (internal) or inside air (external) environment are not identified with any aging effects requiring management. The applicant stated, "There are no applicable aging effects for this material/environment combination. This is consistent with industry guidance." Provide a detailed discussion of the air environments involved, and justify the basis for concluding that there are no aging effects requiring management under such material/environment combinations. Provide a summary description of the stated industry guidance.

TVA RESPONSE RAI 3.2-6

Polymer tubing in Core Spray System (System 75) Table 3.3.3.5 is the Tygon (polyvinyl chloride) tube off the closed drain valve downstream to the drain dirt separator (trap) used in the Keep Fill System (shown on drawing 2-47E814-1). Under normal operating conditions, the internal and external environment is atmospheric air.

Unlike metals, thermoplastics do not display corrosion rates. Rather than depending on an oxide layer for protection, they depend on chemical resistance to the environment to which they are exposed. The plastic is either completely resistant to the environment or it deteriorates. Therefore, acceptability for the use of thermoplastics within an air/gas environment is a design driven criteria. Once the appropriate material is chosen, the system will have no aging effects.

The temperature and radiation damage threshold limits are 200°F and $2x10^7$ Rads, respectively. Neither of these limits is challenged in the application where Tygon is utilized. Ultraviolet radiation includes solar radiation and ultraviolet or fluorescent lamps. Tygon may be degraded when exposed to air and ultraviolet radiation. Therefore, for the external surface of the Tygon tubing, degradation should have been identified as shown in the following revised line item:

Tubing	PB	Polymer	Inside Air (external)	Hardening and loss of strength due to polymer degradation (ultraviolet radiation)	System Monitoring Program (**B.2.1.39**)	V.E.1-b	None	F, 3

Section 3.4 Steam and Power Conversion

NRC RAI 3.4-1

In LRA Tables 3.4.2.1 through 3.4.2.7, carbon and low alloy steel bolting in an inside air (external) or outside air (external) environment is not identified with any aging effects requiring management. The applicant indicated that it is because BFN do not use high yield strength bolting. The applicant is requested to discuss the specific material grading used for the bolting in each of the systems, and justify the basis for concluding that crack initiation/growth due to SCC is not a concern for the bolting during the period of extended operation.

TVA RESPONSE TO RAI 3.4-1

In LRA Tables 3.4.2.1 through 3.4.2.7, carbon and low alloy steel bolting in an inside air (external) or outside air (external) environment has a loss of material aging effect identified. The identified aging management program is the Bolting Integrity Program. As noted, a cracking aging effect is not identified because no high yield bolting materials (yield strength above 150 ksi) were identified and plant operating experience does not indicate an adverse history of bolt cracking.

Stress corrosion cracking (SCC) of bolted closures and fasteners is a condition of high yield strength bolting material where a fastener that is statically loaded well below its yield strength can experience sudden failure. SCC occurs through the combination of high stress (both applied and residual tensile stresses), a corrosive environment, and a susceptible material. SCC of high yield strength bolted closures in BWRs requires a corrosive environment typically attributed to leakage of pressure boundary joints or exposure to wetted ambient environments (indoor, outdoor, buried, and submerged) and the use of thread lubricant containing MoS_2 (molybdenum disulfide).

Potentially susceptible mechanical bolting materials include alloy steels (ASTM A354 Gr BD, A540, and A574) and high yield strength heat-treated alloy steels (heat-treated 4130, 4140, and 4340 material). High yield strength heat-treated alloy steel bolting materials are not specified for piping flanged connections at BFN. High strength bolting of vendor supplied equipment has not been identified for mechanical components (such as pump casing studs or valve body/bonnet studs) where the material specifications are available. A review of the BFN operating experience (PERs and WOs) did not identify any instances where mechanical component failure was attributable to SCC of high strength bolting. The use of MoS_2 thread lubricant is not allowed by site procedures. Therefore, any maintenance on this mechanical equipment would result in the use of non-MoS_2 thread lubricant. Loss of bolting function due to SCC of bolted joints of vendor-supplied mechanical equipment is not expected and no aging management is required for the period of extended operation.

NRC RAI 3.4-2

In LRA Tables 3.4.2.2, 3.4.2.3, 3.4.2.6, and 3.4.2.7, copper alloy components in an inside air (external) environment are not identified with any aging effects requiring management. The applicant stated, "There are no applicable aging effects for this material/environment combination. This is consistent with industry guidance." Provide a detailed discussion of the air environment involved, and justify the basis for concluding that there are no aging effects requiring management under the material/environment combinations. Provide also a summary description of the stated industry guidance.

TVA RESPONSE TO RAI 3.4-2

The copper alloy components exposed to an inside air (external) environment were evaluated individually to determine where condensation or periodic wetting could occur. Copper alloy components containing fluid at a temperature below the dew point of the external environment will be subject to condensation. The identified aging effects/mechanisms were then determined based on the particular copper alloy present and whether condensation or periodic wetting could occur. Based on this evaluation, there were no instances where copper alloys components with > 15% Zn were subjected to an aggressive environment or condensation/periodic wetting. Therefore, no aging effects that require management during the period of extended operation were identified for the copper alloy components in the subject tables. A summary description of the industry guidance for copper alloys is provided in the following table:

Aging Effect/Mechanism Determination for Copper Alloys		
Copper Alloy	Non-wetted environment	• Wetted environment
Copper alloy (<15% Zn)	No aging effects	• MIC if there is a potential source of MIC microbes. • Galvanic corrosion if there is contact with a metal higher in the galvanic series.

Aging Effect/Mechanism Determination for Copper Alloys		
Copper Alloy	Non-wetted environment	• Wetted environment
Copper alloy (>15% Zn)	No aging effects	• Selective leaching • Crevice corrosion, pitting corrosion, and stress corrosion cracking if there is a mechanism / potential for concentrating contaminates. • MIC if there is a potential source of MIC microbes. • Galvanic corrosion if there is contact with a metal higher in the galvanic series.

NRC RAI 3.4-3

In LRA Tables 3.4.2.1, 3.4.2.3, 3.4.2.4, and 3.4.2.5, carbon and low alloy steel bolting in an inside air (external) environment is not identified with any aging effects requiring management. The applicant indicated that carbon and low alloy steels are not susceptible to external general corrosion when temperature is greater than 212°F. The applicant is requested to discuss the specific temperature environment for the bolting, instead of the piping, and justify the basis for concluding that no aging effects need to be identified.

TVA RESPONSE TO RAI 3.4-3

Table 3.4.2.1 for Main Steam System (01), Table 3.4.2.3 for Feedwater System (03), Table 3.4.2.4 for Heater Drain and Vents System (06), and Table 3.4.2.5 for Turbine Drains and Miscellaneous Piping (08) do not identify general corrosion as an aging effect for carbon and low alloy steel bolting in an inside air (external) environment as this bolting is maintained dry by the heat to which it is exposed.

During normal operating conditions, the internal environment of those portions of the above systems within the scope of license renewal is much higher than 212°F (>300°F). Since the bolting connections are constantly in contact with the high temperature components within these systems, the bolting itself within these systems will experience temperatures higher than 212°F. Carbon and low alloy steels are not susceptible to external general corrosion at temperatures above 212°F.

NRC RAI 3.4-4

In LRA Table 3.4.2.3, carbon and low alloy steel components in air/gas (internal) - moist air environments are identified as being susceptible to loss of material due to crevice, galvanic, general, and pitting corrosion. One-Time Inspection Program (B.2.1.29) is credited as the only applicable AMP, in lieu of a program which involves periodic inspections. In LRA Table 3.4.2.6, carbon and low alloy steel and cast iron and cast iron alloy components in raw water (internal) environments are identified as being susceptible to loss of material due to biofouling, MIC, crevice, general, and pitting corrosion. Again, One-Time Inspection Program (B.2.1.29) is credited as the only applicable AMP. One-time inspections are appropriate where material degradation is not expected or is expected at a slow rate in environments such as dehumidified air, but may not be appropriate for moist air or raw water environments. The applicant is requested to provide justification that the One-Time Inspection Program alone, in lieu of a more appropriate periodic inspection program, should be used to manage the aging effects for the above mentioned components and material/environment combinations.

TVA RESPONSE TO RAI 3.4-4

The carbon and low alloy steel components in Feedwater System (03), Table 3.4.2.3 are exposed to an air/gas – moist air environment in two applications. The first application is the small segment between the dual isolation valves on system vents and drains and the second application is valve packing leakoff lines on Unit 1 Feedwater Isolation Valves. These leakoff lines will be removed prior to Unit 1 restart. Although these lines are presently in the scope of license renewal, they are not addressed in this response because they will be deleted prior to the period of extended operation.

This small segment of piping/fittings between the dual isolation valves on system vents and drains is exposed to feedwater quality water when the valves are open to support maintenance activities and has trapped air with varying amount of feedwater, based on how the valves are closed, i.e., the sequence and time between closing the valves. The safety consequences for this short segment of piping failing are minimal as this line is downstream of a closed isolation valve that is manually opened only to support maintenance activities. Minimal degradation is expected based on the quality water potentially in these components. For completeness, BFN will perform inspections to verify these lines are not degrading using the One-Time Inspection Program. This question was also addressed in Question 413 of the NRC's Consistent with GALL Audit {Browns Ferry Nuclear Plant (BFN) - Units 1, 2, and 3 License Renewal Application – Response to NRC Request for Additional Information (RAI) Developed During the License Renewal Audit Inspections for Comparison to Generic Aging Lessons Learned (GALL) During Weeks of June 21, 2004 and July 26, 2004, dated October 8, 2004}.

In LRA Table 3.4.2.6 for Condenser Circulating Water System (27), carbon and low alloy steel and cast iron and cast iron alloy components in raw water (internal) environments are identified as being susceptible to loss of material due to biofouling, MIC, crevice, general, and pitting corrosion. The in-scope components in the Condenser Circulating Water System are those components which provide the anti-siphon vacuum breaker function. Upon re-reviewing the LR scope for Condenser Circulating Water System, it was determined that raw water was inadvertently specified as the internal environment for the anti-siphon vacuum breaker components. The applicable internal environment (air/gas) has already been evaluated for this system and is included in the LRA. The raw water environment will be deleted from this system.

NRC RAI 3.4-5

In LRA Tables 3.4.2.1 and 3.4.2.3, bolting made of carbon and low alloy steel, nickel alloy, and stainless steel in inside air (external) environments are identified as being susceptible to loss of bolting function due to wear. The Bolting Integrity Program is credited as the AMP. LRA Section B.2.1.16, Bolting Integrity Program, does not specifically address loss of bolting function due to wear as an aging effect to be managed by the AMP. The applicant is requested to discuss in detail how the identified aging effect will be managed by the program.

TVA RESPONSE TO RAI 3.4-5

Bolting degradation due to wear (fretting) could potentially occur at locations of repeated relative motion of mechanical component bolted joints. Wear of bolted joint components is generally not a concern; however, for license renewal purposes, wear is being assumed as a potential mechanism for "critical bolting applications." "Critical bolting applications" constitute reactor coolant pressure boundary components where closure bolting failure could result in loss of reactor coolant and jeopardize safe operation of the plant. Loss of material function due to wear is managed by the BFN Bolting Integrity Program. This program specifies inspection requirements in accordance with ASME section XI and recommendations of EPRI NP-5769. These inspection requirements include visual inspections looking for wear besides cracks, corrosion, or physical damage on the surface.

NRC RAI 3.4-6

In LRA Table 3.4.2.2, aluminum alloy fittings and piping in a treated water (internal) environment are identified as being susceptible to crack initiation/growth due to SCC and loss of material due to crevice, galvanic, and pitting corrosion. Explain why loss of material due to general corrosion is not identified as a potential aging effect to be managed during the period of extended operation. For the portion of the condensate system that contains single phase fluid with temperatures < 200°F, explain why flow-accelerated corrosion (FAC) due to erosion is not a concern for the period of extended operation. Explain also how Chemistry Control Program, with association of One-Time Inspection Program, is used to manage the aging effects under the above identified components/material/environment combinations.

TVA RESPONSE TO RAI 3.4-6

Per industry guidance, aluminum and aluminum-based alloys are not susceptible to loss of material due to general corrosion.

Flow-accelerated corrosion is a term that is associated with carbon and low alloy steels. The in scope piping/fittings for the Condensate System are made of an aluminum alloy. Erosion/corrosion is the similar aging effect that could potentially occur for aluminum alloy components. According to industry guidance, erosion/corrosion is conservatively identified as an aging mechanism for aluminum and aluminum alloys in the feedwater, steam, and condensate systems of both PWRs and BWRs and for the HPCI and the RCIC systems in BWRs where the material chromium content is < 1% or the pH is < 9.5. The portions of the Condensate System at BFN that are within the license renewal boundary are the supply lines to the emergency core cooling pumps. These lines contain single phase fluid with temperatures significantly less than 200°F with only periodic flow. Therefore, erosion/corrosion is not an aging mechanism that must be managed for the period of extended operation in the Condensate System.

The main objective of the Chemistry Control Program is to minimize loss of material due to general, crevice, and pitting corrosion and crack initiation and growth caused by stress corrosion cracking. Corrosion and cracking of aluminum alloys in treated water is managed by maintaining oxygen, chlorides, and sulfates within the limits of the Chemistry Control Program. The specific chemistry limits are the same as the limits used to manage aging of carbon/low alloy and stainless steel components in a treated water environment. The use of the Chemistry Control Program is consistent with industry practice as identified in our past precedence review. The One-Time Inspection Program is used to verify the Chemistry Control Program's effectiveness.

NRC RAI 3.4-7

In LRA Table 3.4.2.2, polymer fittings in an inside air (external) or treated water (internal) environment are not identified with any aging effects. The applicant stated, "There are no applicable aging effects for this material/environment combination. This is consistent with industry guidance." Provide a detailed discussion of the air and treated water environments involved, and justify the basis for concluding that there are no aging effects requiring management under such material/environment combinations. Provide a summary description of the stated industry guidance.

TVA RESPONSE TO RAI 3.4-7

Polymer fittings in Table 3.4.2.2 within the condensate system (System 02) are the insulating couplings between carbon steel and stainless steel pipe, and, between aluminum and stainless steel pipe. Acetal (the generic name for a family of polymer products that includes DELRIN) provides high strength and stiffness along with increased dimensional stability and ease of machining. A review of available industry information did not identify any aging effects for DELRIN that would be applicable to the treated water (internal) environment or the inside air (external) environment.

NRC RAI 3.4-8

In LRA Table 3.4.2.2, aluminum alloy valves in a treated water (internal) environment are identified as being susceptible to crack initiation/growth due to SCC and loss of material due to crevice and pitting corrosion. Explain why loss of material due to general and galvanic corrosion is not identified as a potential aging effect to be managed during the period of extended operation. Also, explain how Chemistry Control Program, with association of One-Time Inspection Program, is used to manage the aging effects under the above identified components/material/environment combinations.

TVA RESPONSE TO RAI 3.4-8

Per industry guidance, aluminum and aluminum-based alloys in a treated water environment are not susceptible to loss of material due to general corrosion.

Loss of material due to galvanic corrosion occurs when materials with different electrochemical potentials are in contact in the presence of a corrosive environment. Anodic metals like aluminum will preferentially corrode when coupled with most metals (such as copper, stainless, and carbon steels) in an electrolytically conductive environment. The aluminum valves in Table 3.4.2.2 within the condensate system (system 02) are not in contact with more cathodic materials. Therefore, galvanic corrosion is not a concern for aluminum valves in a treated water environment for the condensate system.

The main objective of the Chemistry Control Program is to minimize loss of material due to general, crevice, and pitting corrosion and crack initiation and growth caused by stress corrosion cracking. Corrosion and cracking of aluminum alloys in treated water is managed by maintaining oxygen, chlorides, and sulfates within the limits of the Chemistry Control Program. The specific chemistry limits are the same as the limits used to manage aging of carbon/low alloy and stainless steel components in a treated water environment. The use of the Chemistry Control Program is consistent with industry practice as identified in our past precedence review. The One-Time Inspection Program is used to verify the Chemistry Control Program's effectiveness.

NRC RAI 3.4-9

In LRA Table 3.4.2.3, stainless steel fittings, piping, valves, and restricting orifice - RCPB in an air/gas (internal) - moist air environment are identified as being susceptible to crack initiation/growth due to SCC and loss of material due to crevice and pitting corrosion. Also, stainless steel (CASS) valves - RCPB in an air/gas (internal) - moist air environment are identified as being susceptible to change in material properties/reduction in fracture toughness due to thermal aging. One-Time Inspection Program is credited to manage the identified aging effects. One-time inspections are appropriate where material degradation is not expected or is expected at a slow rate in environments such as dehumidified air, but may not be appropriate for moist air environments. The applicant is requested to provide justification that the One-Time Inspection Program alone, in lieu of a more appropriate periodic inspection program, should be used to manage the identified aging effects for the above mentioned components and material/environment combinations.

TVA RESPONSE TO RAI 3.4-9

The stainless steel reactor coolant pressure boundary components in Feedwater System (03), Table 3.4.2.3 are exposed to an air/gas environment when air is trapped in the Vessel Flange Leak Detection (VFLD) line when the vessel head is secured. The air/gas environment is considered moist air because the trapped air is not dried and there is a small potential for leakage. The aging effects are conservatively identified for moist air environment.

Fittings are addressed in line items 19 and 20. The aging management programs identified for cracking are the ASME Section XI Subsections IWB, IWC, and IWD Inservice Inspection Program and the One-Time Inspection Program. For loss of material, the applicable aging management program is the One-Time Inspection Program. These same aging effects and aging management programs should be shown for each applicable component. Piping is addressed in line items 40 and 41. Restricting orifices are addressed in line item 46. Line item 46 should be replaced by the following line items:

Restricting Orifice - RCPB	FR, PB	Stainless Steel	Air/gas (internal) - moist air	Crack initiation/growth due to cyclic loading and SCC.	ASME Section XI Subsections IWB, IWC and IWD Inservice Inspection Program (B.2.1.4) One-Time Inspection Program (B.2.1.29)	IV.C1.1-i	None	G.5
Restricting Orifice - RCPB	FR, PB	Stainless Steel	Air/gas (internal) - moist air	Loss of material due to crevice and pitting corrosion.	One-Time Inspection Program (B.2.1.29)	V.C1.1-c	None	F.5

Valves are addressed in line items 68 and 69. The Boiling Water Reactor Stress Corrosion Cracking Program is the appropriate aging management program for the cracking aging effect of stainless steel reactor coolant pressure boundary valves in line item 68. Line item 68 should be replaced with the following line item:

Valves - RCPB	PB	Stainless Steel	Air/gas (internal) - moist air	Crack initiation/growth due SCC.	Boiling Water Reactor Stress Corrosion Cracking Program (B.2.1.10)	IV.C1.3-c	None	G.5

For the cracking aging effect for piping components less than 4 inches NPS, GALL Item IV.C1.1-i requires, "A plant-specific destructive examination or a nondestructive examination (NDE) that permits inspection of the inside surfaces of the piping is to be conducted to ensure that cracking has not occurred and the component intended function will be maintained during the extended period of operation." BFN has included this small bore piping inspection in the One-Time Inspection Program.

For the loss of material aging effects, a one-time inspection is specified for the stainless steel components as corrosion is not expected to occur. The piping is not subject to condensation and is dry except for the abnormal case where reactor vessel flange leakage should occur. Any water that is introduced to this line is reactor grade treated water and as such has minimal potential for corrosion.

Thermal aging of CASS valves is addressed in line item 67. The incorrect aging management program was inadvertently identified. The correct aging management program is the ASME Section XI Subsections IWB, IWC, and IWD Inservice Inspection Program. Line item 67 should be replaced with the following line item:

Valves - RCPB	PB	Stainless Steel - CASS	Air/gas (internal) - moist air	Change in material properties /reduction in fracture toughness due to thermal aging.	ASME Section XI subsections IWB, IWC and IWD Inservice Inspection Program (B.2.1.4)	IV.C1.3-b	None	G.5