components from these five aging mechanisms include cracking, change in material properties, and loss of material.

(1) Freeze-thaw

Section 3.5.2.2.1.1 of the SRP-LR does not address freeze-thaw as an aging mechanism for concrete containments because the GALL Report does not recommend further evaluation. However, ISG-3 clarifies the staff position that further evaluation is appropriate if the applicant's facility is subject to moderate to severe weathering conditions, unless the concrete meets certain specifications and subsequent inspections have confirmed that the aging mechanism has not caused degradation of the concrete.

ANO-2 is located in a region considered to be subject to moderate weathering conditions. In the LRA, the applicant stated that ANO-2 concrete structures are designed in accordance with American Concrete Institute (ACI) specification ACI 318-63, "Building Code Requirements for Reinforced Concrete," which results in low permeability and resistance to aggressive chemical solutions by requiring the following:

- high cement content
- low water-to-cement ratio
- proper curing
- adequate air entrainment

The applicant stated in the LRA that ANO-2 concrete also meets the requirements of ACI 201.2R-77, "Guide to Durable Concrete." Both ACI 318-63 and ACI201.2R-77 use the same ASTM standards for selection, application, and testing of concrete.

The staff interviewed members of the applicant's technical staff and reviewed relevant operating experience to confirm that loss of material due to freeze-thaw has not been observed, either through the Containment Inservice Inspection Program or the Structures Monitoring Program.

Because concrete that satisfies the requirements of ACI 318-63 will meet the requirements of ISG-3, and on the basis of an audit of operating experience evaluated under the Containment Inservice Inspection Program and Structures Monitoring Program, the staff finds that the Containment Inservice Inspection Program will adequately manage the loss of material and cracking due to freeze-thaw.

(2) Leaching of calcium hydroxide

Section 3.5.2.2.1.1 of the SRP-LR states that cracking, spalling, and increases in porosity and permeability caused by the leaching of calcium hydroxide could occur in inaccessible areas of PWR concrete and steel containments. The GALL Report, as updated by ISG-3, recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific criteria cannot be satisfied.

The GALL Report states that leaching of calcium hydroxide becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well cured, and has low permeability, and that cracking is well controlled.

The applicant stated in the LRA that ANO-2 concrete structures are designed in accordance with ACI 318-63 and meet the requirements of ACI 201.2R-77.

The staff finds that because ACI 318 provides assurance that the recommendations of the GALL Report and ISG-3 are met, leaching of calcium hydroxide is not significant at ANO-2. Therefore, the staff concludes that the Containment Inservice Inspection Program will be sufficient for management of increases in porosity and permeability due to this aging mechanism. A plant-specific AMP is not required to address this aging effect.

(3) Aggressive chemical attack

Section 3.5.2.2.1.1 of the SRP-LR states that cracking, spalling, and increases in porosity and permeability caused by aggressive chemical attack could occur in inaccessible areas of PWR concrete and steel containments. The GALL Report recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific recommendations of the GALL Report and updated in ISG-3 cannot be satisfied.

The GALL Report, as updated by ISG-3, states that aggressive chemical attack is not significant unless pH is less than 5.5, chlorides are greater than 500 parts per million (ppm), or sulfates are greater than 1500 ppm. In addition, ISG-3 states that a plant-specific program is required to examine representative samples of belowgrade concrete when excavated for any reason.

The applicant stated in the LRA that the belowgrade environment is not aggressive (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1500 ppm). In addition, the staff noted that the applicant used the Structures Monitoring Program for the examination of belowgrade concrete when it is exposed by excavation.

On the basis of the information provided by the applicant in the LRA and the guidelines provided in the SRP-LR, the GALL Report, and ISG-3, the staff finds that increases in porosity and permeability, loss of material (e.g., spalling and scaling), and cracking caused by aggressive chemical attack are not significant for concrete in inaccessible areas. The staff finds that an appropriate plant-specific program for examination of belowgrade concrete has been identified.

(4) Reaction with aggregates

Section 3.5.2.2.1.1 of the SRP-LR does not address reaction with aggregates as an aging mechanism for concrete containments because the GALL Report does not recommend further evaluation. However, ISG-3 clarifies the staff position that further evaluation is appropriate if investigations, tests, or examinations have demonstrated that the aggregates are reactive.

The applicant stated in the LRA that ANO-2 concrete structures are designed in accordance with ACI 318-63 and meet the requirements of ACI 201.2R-77. The ACI standards call for the testing of aggregates at the time of construction. Through interviews with the applicant's technical staff, the staff confirmed that the results of those tests show that the aggregates used for concrete containment at ANO-2 are not reactive.

(5) Corrosion of embedded steel

Section 3.5.2.2.1.1 of the SRP-LR states that loss of material due to corrosion of embedded steel could occur in inaccessible areas of PWR concrete and steel containments. The GALL Report (updated in ISG-3) recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific recommendations of the GALL Report cannot be satisfied.

For cracking, loss of bond, and loss of material (e.g., spalling and scaling) due to the corrosion of embedded steel, the GALL Report states that a plant-specific program is only required if the belowgrade environment is aggressive. In addition, ISG-3 states that a plant-specific program is required to examine representative samples of belowgrade concrete when excavated for any reason.

The applicant stated in the LRA that the belowgrade environment is not aggressive (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1500 ppm). In addition, the staff noted that the applicant used the Structures Monitoring Program for the examination of belowgrade concrete when it is exposed by excavation.

Through interviews with the applicant's technical staff, the staff determined that the environment at the time of construction was not aggressive and, on the basis of subsequent testing, the environment has remained within the limits identified in the GALL Report. The staff finds that, in accordance with the recommendations of the GALL Report, this aging effect is not significant and is adequately managed.

The staff reviewed the results of the applicant's AMR for inaccessible concrete areas. On the basis of its review, the staff finds that the applicant appropriately evaluated AMR results involving management of aging of inaccessible concrete areas for containment, as recommended in the GALL Report and ISG-3. The staff finds that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.1.2 Cracking, Distortion, and Increase in Component Stress Level due to Settlement; Reduction of Foundation Strength due to Erosion of Porous Concrete Subfoundations, If Not Covered by Structures Monitoring Program. In Section 3.5.2.2.1.2 of the LRA, the applicant addressed (1) cracking, distortion, and increase in component stress level due to settlement and (2) reduction of foundation strength due to erosion of porous concrete subfoundations in the containment. The applicant used the Structures Monitoring Program (AMP B.1.27), which monitors accessible areas for evidence of aging effects that may apply to containment structures. Section 3.0.3.1 of this SER evaluates this program, which is consistent with GALL AMP XI.S6, "Structures Monitoring Program."

Section 3.5.2.2.1.2 of the SRP-LR states that cracking, distortion, and increase in component stress level due to settlement could occur in PWR concrete and steel containments. In addition, reduction of foundation strength due to erosion of porous concrete subfoundations could occur in all types of PWR containments. Some plants may rely on a dewatering system to lower the site ground water level. If the plant's CLB credits a dewatering system, the GALL Report recommends verification of the continued functionality of the dewatering system during the period of extended operation. The GALL Report recommends no further evaluation if this activity is included in the scope of the applicant's structures monitoring program.

The applicant stated in the LRA that ANO-2 does not rely on a dewatering system for control of settlement because seismic Category 1 structures are founded on sound bedrock. Concrete within 5 feet of the highest known ground water level is protected by membrane waterproofing, which protects the containment building concrete against exposure to ground water. Consequently, IN 97-11 does not identify ANO-2 as a plant susceptible to erosion of porous concrete subfoundations. Ground water was not aggressive during plant construction, and no changes in ground water conditions have been observed. Finally, the applicant has included these components within the plant-specific structures monitoring program, which will confirm that these aging effects are adequately managed.

The staff reviewed the AMR results involving management of aging effects resulting due to settling and erosion of porous concrete subfoundations and confirmed that the Structures Monitoring Program addresses each of the affected SCs. On the basis of this review, the staff finds that the applicant has appropriately evaluated AMR results involving cracking, distortion, and increase in component stress level due to settlement and reduction of foundation strength due to erosion, as recommended in the GALL Report.

3.5.2.2.1.3 Reduction of Strength and Modulus of Concrete Structures due to Elevated Temperature. In Section 3.5.2.2.1.3 of the LRA, the applicant addressed reduction of strength and modulus of concrete structures due to elevated temperature in containments.

Section 3.5.2.2.1.3 of the SRP-LR states that reduction of strength and modulus of elasticity due to elevated temperatures could occur in PWR concrete and steel containments. The GALL Report calls for a plant-specific AMP and recommends further evaluation if any portion of the concrete containment components exceeds specified temperature limits (i.e., general area temperature 66 °C (150 °F) and local area temperature 93 °C (200 °F)).

The applicant stated in the LRA that, during normal operation, all concrete areas within containment are below 66 °C (150 °F) ambient temperature. The applicant concluded that its containment concrete structures are not subject to changes in material properties due to elevated temperature. The applicant has included these components within the scope of AMP B.1.27, "Structures Monitoring—Structures Monitoring," and AMP B.1.13, "Inservice Inspection—Containment Inservice Inspection," to monitor for indications of change in material properties for containment concrete aging effects.

The staff reviewed the AMR results involving management of aging effects resulting from elevated temperature and confirmed that the Containment Inservice Inspection Program and Structures Monitoring Program address each of the affected SCs. On the basis of this audit and review, the staff finds that the applicant has appropriately evaluated AMR results involving reduction of strength and modulus due to elevated temperature, as recommended in the GALL Report.

In addition, because the concrete is not exposed to elevated temperatures, the staff finds that the plant-specific AMPs are acceptable for management of this aging effect, and no further evaluation is required.

The staff finds that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.1.4 Loss of Material due to Corrosion in Inaccessible Areas of Steel Containment Shell or Liner Plate. In Section 3.5.2.2.1.4 of the LRA, the applicant addressed loss of material due to corrosion in inaccessible areas of the steel containment shell or the steel liner plate for the containment.

Section 3.5.2.2.1.4 of the SRP-LR states that loss of material due to corrosion could occur in inaccessible areas of the steel containment shell or the steel liner plate for all types of PWR containments. The GALL Report recommends further evaluation of plant-specific programs to manage this aging effect for inaccessible areas if the following four specific recommendations of the GALL Report cannot be satisfied:

(1) Concrete meeting the requirements of ACI 318 or 349 and the guidance of ACI 201.2R was used for the containment concrete in contact with the embedded containment shell or liner.

(2) The accessible concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner.

(3) The accessible portion of the moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements.

(4) Borated water spills and water ponding on the containment concrete floor are not common and, when detected, are cleaned up in a timely manner.

The applicant stated in the LRA that the containment concrete in contact with the steel liner plate is designed in accordance with ACI 318-63 and meets the requirements of ACI 201.2R-77. Accessible concrete is monitored for cracks under the Structures Monitoring Program, evaluated in Section 3.0.3.1 of this SER. The accessible portions of the steel liner plate and moisture barrier where the liner becomes embedded are inspected in accordance with the Containment Inservice Inspection Program (IWE), evaluated in Section 3.0.3.3.4 of this SER. Spills (e.g., borated water spill) are cleaned up in a timely manner. The aging effect of loss of material due to corrosion has not been significant for this liner plate.

Since the applicant satisfied all of the recommendations of the GALL Report, the staff finds that no additional plant-specific AMP is required to manage inaccessible areas of the steel containment liner plate.

3.5.2.2.1.5 Loss of Prestress due to Relaxation, Shrinkage, Creep, and Elevated Temperature. As stated in the SRP-LR, loss of prestress due to relaxation, shrinkage, creep, and elevated temperature is a TLAA, as defined in 10 CFR 54.3. All TLAAs must be evaluated in accordance with 10 CFR 54.21(c)(1). Section 4.5 of this SER documents the staff's review of the applicant's evaluation of this TLAA. In performing this review, the staff followed the guidance in Section 4.5 of the SRP-LR.

3.5.2.2.1.6 Cumulative Fatigue Damage. As stated in the SRP-LR, fatigue is a TLAA, as defined in 10 CFR 54.3. All TLAAs must be evaluated in accordance with 10 CFR 54.21(c)(1). Section 4.6 of this SER documents the staff's review of the applicant's evaluation of this TLAA. In performing this review, the staff followed the guidance in Section 4.6 of the SRP-LR.

3.5.2.2.1.7 Cracking Caused by Cyclic Loading and Stress-Corrosion Cracking. In Section 3.5.2.2.1.7 of the LRA, the applicant addressed aging mechanisms that can lead to the cracking of penetration sleeves and penetration bellows, such as cyclic loads and SCC.

Section 3.5.2.2.1.7 of the SRP-LR states that cracking of containment penetrations (including penetration sleeves, penetration bellows, and dissimilar metal welds) due to cyclic loading or SCC could occur in containments. The SRP-LR recommends further evaluation of inspection methods to detect cracking caused by cyclic loading and SCC since visual testing (VT)-3 examinations may be unable to detect this aging effect.

(1) Cracking caused by SCC

The GALL AMP XI.S1, "ASME Section XI Subsection IWE," covers inspection of these items under examination categories E-B, E-F, and E-P (pressure tests in Appendix J to 10 CFR Part 50). Title 10, Section 50.55a, of the *Code of Federal Regulations* (10 CFR 50.55a) identifies examination categories E-B and E-F as optional during the current term of operation. For the extended period of operation, examination categories E-B and E-F and additional appropriate examinations to detect SCC in bellows assemblies and dissimilar metal welds are warranted to address this issue.

To manage this aging effect, the applicant used the Containment Leak Rate Program (AMP B.1.6) and the Containment Inservice Inspection Program (AMP B.1.13). Section 3.0.3.1 of this SER documents the staff's evaluation of the Containment Leak Rate Program. The staff determined that the Containment Inservice Inspection Program AMP B.1.13, evaluated in Section 3.0.3.3.4 of this SER, required enhancement and additional appropriate examinations to detect SCC in bellows assemblies and dissimilar metal welds using examination categories E-B and E-F.

In a letter dated April, 14, 2004, the staff asked the applicant to provide additional information regarding the containment pressure boundary bellows, relevant operating experience, and methods used to detect their age-related degradation. The staff noted that the Containment Inservice Inspection Program and Containment Leak Rate Program cannot detect cracking caused by SCC (see NRC IN 92-20, "Inadequate Local Leak Rate Testing").

By letter dated May 19, 2004, the applicant stated that the penetration bellows (LRA Table 3.5.1, Item 3.5.1-3) pertains to carbon steel penetrations, which are not susceptible to SCC and are consistent with the GALL Report, but do not require further evaluation. In addition, the applicant stated that LRA Table 3.5.1, Item 3.5.1-2, addresses SCC of stainless steel penetration bellows. The applicant further stated that bellows are not used for piping system containment penetrations at ANO-2 and that Item 3.5.1-2 applies to the fuel transfer tube sleeve, but not to the bellows, since the bellows are not part of the containment penetration boundary.

Because the bellows are not used for piping system containment penetrations, and based on the staff's review of the applicant's response, the staff finds this acceptable.

(2) Cracking caused by cyclic loading

As stated in the SRP-LR, cracking caused by cyclic loading of the liner plate and penetrations is a TLAA, as defined in 10 CFR 54.3. All TLAAs must be evaluated in accordance with 10 CFR 54.21(c)(1). Section 4.6 of this SER documents the staff's review of the applicant's evaluation. In performing this review, the staff followed the guidance in Section 4.6 of the SRP-LR.

3.5.2.2.2 Class 1 Structures

The staff reviewed Section 3.5.2.2.2 of the LRA against the criteria in Section 3.5.2.2.2 of the SRP-LR, which addresses several areas discussed below.

3.5.2.2.2.1 Aging of Structures Not Covered by Structures Monitoring Program. In Section 3.5.2.2.2.1 of the LRA, the applicant addressed aging of Class 1 structures not covered by the Structures Monitoring Program.

Section 3.5.2.2.2.1 of the SRP-LR states that the GALL Report recommends further evaluation of certain structure/aging effect combinations if they are not covered by the Structures Monitoring Program. As described in Chapter III of the GALL Report, this includes (1) scaling, cracking, and spalling due to repeated freeze-thaw for Group 1–3, 5, and 7–9 structures, (2) scaling, cracking, spalling, and increase in porosity and permeability caused by leaching of calcium hydroxide and aggressive chemical attack for Group 1–5 and 7–9 structures, (3) expansion and cracking due to reaction with aggregates for Group 1–5 and 7–9 structures, (4) cracking, spalling, loss of bond, and loss of material due to corrosion of embedded steel for Group 1–5 and 7–9 structures, (5) cracks, distortion, and increase in component stress level caused by settlement for Group 1–3, 5, and 7–9 structures, (6) reduction of foundation strength caused by erosion of porous concrete subfoundations for Group 1–3 and 5–9 structures, (7) loss of material due to corrosion of structural steel components for Group 1–5 and 7–8 structures, (8) loss of strength and modulus of concrete structures due to elevated temperatures for Groups 1–5, and (9) crack initiation and growth due to SCC and loss of material due to crevice corrosion of stainless steel liner for Group 7–8 structures. Further evaluation is necessary only for structure/aging effect combinations not covered by the Structures Monitoring Program.

Subsection 3.5.2.2.1.2 of the SRP-LR provides technical details of the aging management issue for structure/aging effect combinations (5) and (6) above. Subsection 3.5.2.2.1.3 of the SRP-LR gives the details for item (8) above.

In Table 3.5-1, Item 20, the applicant credited its Structures Monitoring Program for all types of aging effects and all component groups (except Group 6) of accessible interior and exterior concrete and steel components of Class 1 structures. Section 3.0.3.1 of this SER evaluates this program. Additional discussion of specific structure/aging effect combinations follows.

(1) Freeze-thaw

Section 3.5.2.2.1.2 of the SRP-LR does not address freeze-thaw as an aging mechanism for concrete containments, because no further evaluation is recommended in the GALL Report. However, ISG-3 clarifies the staff position that further evaluation is appropriate if the applicant's facility is subject to moderate to severe weathering conditions, unless the concrete meets certain specifications and subsequent inspections have confirmed that the aging mechanism has not caused degradation of the concrete.

ANO-2 is located in a region considered to be subject to moderate weathering conditions. In the LRA, the applicant stated that ANO-2 structures are designed in accordance with ACI 318-63, which results in low permeability and resistance to aggressive chemical solutions by requiring the following:

- high cement content
- low water-to-cement ratio
- proper curing
- adequate air entrainment

In addition to ACI 318-63, ANO-2 concrete also meets the requirements of ACI 201.2R-77. Both ACI 318-63 and ACI201.2R-77 use the same ASTM standards for selection, application, and testing of concrete.

The staff interviewed members of the applicant's technical staff and reviewed relevant operating experience to confirm that loss of material due to freeze-thaw has not been observed, either through the Containment Inservice Inspection Program or the Structures Monitoring Program.

Because concrete that satisfies the requirements of ACI 318-63 will meet the requirements of ISG-3, and on the basis of an audit of operating experience evaluated under the Structures Monitoring Program, the staff finds that the Structures Monitoring Program will adequately manage the loss of material and cracking due to freeze-thaw.

(2)(a) Leaching of calcium hydroxide

Section 3.5.2.2.2.1 of the SRP-LR states that cracking, spalling, and increases in porosity and permeability due to leaching of calcium hydroxide could occur in inaccessible areas of PWR concrete and steel containments. The GALL Report, as updated by ISG-3, recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas exposed to flowing water, unless the requirements of ACI 201.2R are met.

The GALL Report states that leaching of calcium hydroxide becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well cured, and has low permeability, and that cracking is well controlled.

The applicant stated in the LRA that concrete structures are designed in accordance with ACI 318-63 and meet the requirements of ACI 201.2R-77.

The staff finds that the use of ACI 318 provides assurance that the recommendations of the GALL Report and ISG-3 are met and leaching of calcium hydroxide is not significant at ANO-2. Therefore, the staff concludes that the Structures Monitoring Program will sufficiently manage increases in porosity and permeability due to this aging mechanism. A plant-specific AMP is not required to address this aging effect.

(2)(b) Aggressive chemical attack

Section 3.5.2.2.2.1 of the SRP-LR states that cracking, spalling, and increases in porosity and permeability due to aggressive chemical attack could occur in inaccessible areas of Class 1 structures. The GALL Report recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific recommendations of the GALL Report and the updates in ISG-3 cannot be satisfied.

The GALL Report, as updated by ISG-3, states that aggressive chemical attack is not significant unless pH is less than 5.5, chlorides are greater than 500 ppm, or sulfates are greater than 1500 ppm. In addition, ISG-3 states that a plant-specific program is required to examine representative samples of belowgrade concrete when excavated for any reason.

The applicant stated in the LRA that the belowgrade environment is not aggressive (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1500 ppm). In addition, the staff noted that the applicant used the Structures Monitoring Program for the examination of belowgrade concrete when it is exposed by excavation.

On the basis of the information given in the LRA and the guidelines provided in the SRP-LR, the GALL Report, and ISG-3, the staff finds that increases in porosity and permeability, loss of material (e.g., spalling and scaling), and cracking caused by aggressive chemical attack are not significant for concrete in inaccessible areas. The staff finds that the applicant identified an appropriate plant-specific program for examination of belowgrade concrete (specifically, an enhancement to the Structures Monitoring Program).

(3) Reaction with aggregates

Section 3.5.2.2.2.1 of the SRP-LR does not address reaction with aggregates as an aging mechanism for concrete containments, because no further evaluation is recommended in the GALL Report. However, ISG-3 clarifies the staff position that further evaluation is appropriate if investigations, tests, or examinations have demonstrated that the aggregates are reactive.

The applicant stated in the LRA that ANO-2 concrete structures were designed in accordance with ACI 318-63 and meet the requirements of ACI 201.2R-77. The ACI standards call for the testing of aggregates at the time of construction.

Through interviews with the applicant's technical staff, the staff confirmed that the results of those tests showed that the aggregates used for concrete Class 1 structures at ANO-2 are not reactive.

(4) Corrosion of embedded steel

Section 3.5.2.2.2.1 of the SRP-LR states that loss of material due to corrosion of embedded steel could occur in inaccessible areas of Class 1 structures. The GALL Report (updated in ISG-3) recommends further evaluation of plant-specific programs to manage the aging effects for inaccessible areas if specific recommendations of the GALL Report cannot be satisfied.

For cracking, loss of bond, and loss of material (e.g., spalling and scaling) due to corrosion of embedded steel, the GALL Report states that a plant-specific program is only required if the belowgrade environment is aggressive. In addition, ISG-3 states that a plant-specific program is required to examine representative samples of belowgrade concrete when excavated for any reason.

The applicant stated in the LRA that the belowgrade environment is not aggressive. In interviews with the applicant's technical staff, the staff determined that the environment at the time of construction had a measured pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1500 ppm, and, on the basis of subsequent testing, it has remained within these limits.

The staff finds that, in accordance with the recommendations of the GALL Report, this aging effect is not significant and is adequately managed by the enhanced Structures Monitoring Program. Section 3.0.3.1 of this SER documents the staff's evaluation of this program.

(5) Settlement

Section 3.5.2.2.2.1 of the SRP-LR refers to Section 3.5.2.2.1.2 for a discussion of settlement. Section 3.5.2.2.1.2 of the SRP-LR states that cracking, distortion, and increase in the component stress level due to settlement could occur in Class 1 structures. Some plants may rely on a dewatering system to lower the site ground water level. If the plant's CLB credits a dewatering system, the GALL Report recommends verification of the continued functionality of the dewatering system during the period of extended operation. The GALL Report recommends no further evaluation if this activity is included in the scope of the applicant's structures monitoring program.

The applicant stated in the LRA that ANO-2 does not rely on a dewatering system for control of settlement because Class 1 structures are founded on sound bedrock. Concrete within 5 feet of the highest known ground water level is protected by membrane waterproofing, which protects the containment building concrete against exposure to ground water. Consequently, IN 97-11 does not identify ANO-2 as a plant susceptible to erosion of porous concrete subfoundations. Ground water was not aggressive during plant construction, and no changes in ground water conditions have been observed. The applicant also included these components within the plant-specific structures monitoring program, which will confirm that these aging effects are adequately managed.

The staff reviewed the AMR results involving management of aging effects resulting from settling and erosion of porous concrete subfoundations and confirmed that the Structures Monitoring Program addresses each of the affected SCs. On the basis of this review, the staff finds that the applicant has appropriately evaluated AMR results involving cracking, distortion, and increase in the component stress level due to settlement and reduction of foundation strength due to erosion, as recommended in the GALL Report.

(6) Erosion of porous concrete subfoundation

Section 3.5.2.2.2.1 of the SRP-LR refers to Section 3.5.2.2.1.2 for discussion of erosion of porous concrete subfoundation. Section 3.5.2.2.1.2 of the SRP-LR states that reduction of foundation strength due to erosion of porous concrete subfoundations could occur in all types of

Class 1 structures. Some plants may rely on a dewatering system to lower the site ground water level. If the plant's CLB credits a dewatering system, the GALL Report recommends verification of the continued functionality of the dewatering system during the period of extended operation. The GALL Report recommends no further evaluation if this activity is included in the scope of the applicant's structures monitoring program.

Information Notice 97-11 does not identify ANO-2 as a plant susceptible to erosion of porous concrete subfoundations. Ground water was not aggressive during plant construction, and there is no indication that ground water chemistry has significantly changed. The applicant has not observed any changes in ground water conditions at ANO-2. Therefore, the staff finds that cracking, distortion, and increase in the component stress level due to settlement and reduction of foundation strength due to erosion of the porous concrete subfoundation are adequately managed by the Structures Monitoring Program.

(7) Corrosion of structural steel components

Section 3.5.2.2.1 of the SRP-LR states that corrosion of structural steel components could occur and that further evaluation is necessary only for structure/aging effect combinations not covered by a structures monitoring program.

The staff reviewed the AMR results involving management of aging effects resulting from corrosion of structural steel components and confirmed that the Structures Monitoring Program, evaluated in Section 3.0.3.1 of this SER, addresses each of the affected SCs. On the basis of this audit and review, the staff finds that the applicant has appropriately evaluated AMR results involving this aging effect and that the Structures Monitoring Program adequately manages the corrosion of structural steel components.

(8) Elevated temperatures

Section 3.5.2.2.2.1 of the SRP-LR refers to Section 3.5.2.2.1.3 for discussion of elevated temperatures. Section 3.5.2.2.1.3 of the SRP-LR states that reduction of strength and modulus of elasticity due to elevated temperatures could occur in Class 1 structures in Groups 1–5. The GALL Report calls for a plant-specific AMP and recommends further evaluation if any portion of the concrete components exceeds specified temperature limits (i.e., general area temperature 66 °C (150 °F) and local area temperature 93 °C (200 °F)).

The applicant stated in the LRA that, during normal operation, all concrete areas in Class 1 structures are below 66 °C (150 °F) ambient temperature. The applicant concluded that ANO-2 Class 1 concrete structures are not subject to change in material properties due to elevated temperature.

The staff reviewed the AMR results involving management of aging effects resulting from elevated temperature and confirmed that the Structures Monitoring Program, evaluated in Section 3.0.3.1 of this SER, addresses each of the affected SCs. On the basis of this review, the staff finds that the applicant has appropriately evaluated AMR results involving reduction of strength and modulus due to elevated temperature, as recommended in the GALL Report, and that it is adequately managed by the Structures Monitoring Program.

(9) Aging effects for stainless steel liners for tanks

The applicant stated that the structural AMRs do not include tanks with stainless steel liners. Instead, the applicant considered tanks subject to an AMR with their respective mechanical systems. The staff confirmed that LRA Tables 3.5.2-1 through 3.5.2-4 do not include tanks with stainless steel liners.

On the basis of its review, the staff finds that the applicant has appropriately evaluated AMR results involving management of aging of accessible interior and exterior concrete and steel components of Class 1 structures (except Group 6 water-control structures), and all are covered by the Structures Monitoring Program. This is consistent with the recommendations of the GALL Report. The staff finds that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.2.2 Aging Management of Inaccessible Areas. In Section 3.5.2.2.2.2 of the LRA, the applicant addressed aging of inaccessible areas of Class 1 structures.

Section 3.5.2.2.2.2 of the SRP-LR states that cracking, spalling, and increases in porosity and permeability caused by aggressive chemical attack and cracking, spalling, loss of bond, and loss of material due to corrosion of embedded steel could occur in belowgrade inaccessible concrete areas. The GALL Report recommends further evaluation to manage these aging effects in inaccessible areas of Group 1–3, 5, and 7–9 structures, if an aggressive belowgrade environment exists. ISG-3 identifies additional requirements.

The GALL Report, as updated by ISG-3, states that aggressive chemical attack and corrosion of embedded steel is not significant unless pH is less than 5.5, chlorides are greater than 500 ppm, or sulfates are greater than1500 ppm. In addition, ISG-3 states that a plant-specific program is required to examine representative samples of belowgrade concrete when excavated for any reason.

In the LRA, the applicant stated that the belowgrade environment is not aggressive (i.e., pH greater than 5.5, chlorides less than 500 ppm, and sulfates less than 1500 ppm). The applicant used the Structures Monitoring Program, evaluated in Section 3.0.3.1 of this SER, to examine belowgrade concrete when it is exposed by excavation. The applicant also stated that inspections of accessible concrete have not revealed degradation due to aggressive chemical attack or corrosion of embedded steel.

Because the belowgrade environment is not aggressive and the applicant will continue to monitor excavated concrete, the staff finds that increases in porosity and permeability, loss of material (e.g., spalling and scaling), and cracking due to aggressive chemical attack and cracking, spalling, loss of bond, and loss of material caused by corrosion of embedded steel are adequately managed for concrete in inaccessible areas.

3.5.2.2.3 Component Supports

The staff reviewed Section 3.5.2.2.3 of the LRA against the criteria in Section 3.5.2.2.3 of the SRP-LR, which addresses several areas discussed below.

3.5.2.2.3.1 <u>Aging of Supports Not Covered by Structures Monitoring Program</u>. In Section 3.5.2.2.3.1 of the LRA, the applicant addressed aging of component supports that are not managed by the Structures Monitoring Program.

Section 3.5.2.2.3.1 of the SRP-LR states that the GALL Report recommends further evaluation of certain component support/aging effect combinations if they are not covered by a structures monitoring program. This includes (1) reduction in concrete anchor capacity due to degradation of the surrounding concrete for Group B1–B5 supports, (2) loss of material due to environmental corrosion for Group B2–B5 supports, and (3) reduction/loss of isolation function due to degradation of vibration isolation elements for Group B4 supports. Further evaluation is necessary only for structure/aging effect combinations not covered by a structures monitoring program.

The applicant's Structures Monitoring Program includes component supports at ANO-2, evaluated in Section 3.0.3.1 of this SER, for Groups B2–B5. The Inservice Inspection Program manages component supports in Group B1, evaluated in Section 3.0.3.4 of this SER.

(1) Reduction in concrete anchor capacity due to surrounding concrete for Group B1–B5 supports

The Structures Monitoring Program includes ANO-2 concrete anchors and surrounding concrete (Groups B2–B5). The Inservice Inspection Program includes these for Group B1.

(2) Loss of material due to environmental corrosion for Group B2–B5 supports

Loss of material due to corrosion of steel support components is an AERM at ANO-2. The Structures Monitoring Program manages this aging effect.

(3) Reduction/loss of isolation function due to degradation of vibration isolation elements for Group B4 supports

The LRA did not identify any vibration isolation elements subject to aging management.

The staff finds that the applicant has appropriately evaluated AMR results involving management of aging of component supports, as recommended in the GALL Report. The staff finds that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.2.3.2 <u>Cumulative Fatigue Damage due to Cyclic Loading</u>. As stated in the SRP-LR, fatigue is a TLAA, as defined in 10 CFR 54.3. All TLAAs must be evaluated in accordance with 10 CFR 54.21(c)(1). Section 4.3 of this SER includes the staff's review of the applicant's evaluation of this TLAA. In performing this review, the staff followed the guidance in Section 4.3 of the SRP-LR.

3.5.2.2.4 Quality Assurance for Aging Management of Nonsafety-Related Components

Section 3.0.4 of this SER provides the staff's evaluation of the applicant's Quality Assurance Program.

Conclusion

On the basis of its audit and review, the staff finds that the applicant's further evaluations, conducted in accordance with the GALL Report, are consistent with the acceptance criteria in Section 3.5.2.2 of the SRP-LR. Since the applicant's AMR results are otherwise consistent with the GALL report, the staff finds that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.5.2.3 AMR Results That Are Not Consistent with the GALL Report

3.5.2.3.1 Containment and Containment Internals

Summary of Technical Information in the Application

In Section 3.5.2.1.1 of the LRA, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the containment and containment internals components:

- Boric Acid Corrosion Prevention Program
- Containment Leak Rate Program
- Inservice Inspection—Containment Inservice Inspection Program
- Inservice Inspection—Inservice Inspection Program
- Structures Monitoring Program

In Table 3.5.2-1 of the LRA, the applicant provided a summary of AMRs for the containment and containment internals components and identified which AMRs it considered to be consistent with the GALL Report.

Staff Evaluation

Table 3.5.2-1 of the LRA indicates that the AMR results of the following items are consistent with their corresponding GALL Report items for the component, material, environment, aging effects, and AMPs:

- abovegrade concrete dome, wall, ring girder, and buttresses
- belowgrade concrete wall and buttresses
- concrete foundation
- concrete internal structures
- personal airlock and equipment hatch

In discussing LRA Table 3.5.1, Item 3.5.1-3, the applicant asserted that the ANO-2 Containment Inservice Inspection Program and Containment Leak Rate Testing program will monitor loss of material due to corrosion of penetration bellows. Under Item A3.1 (page II

A3.6), the GALL Report recommends further evaluation regarding the SCC of containment bellows. The staff asked the applicant to provide additional information regarding the containment pressure boundary bellows at ANO-2, relevant operating experience, and method(s) used to detect their age-related degradation. The staff noted that, in many cases, VT-3 examination of IWE and Type B (Appendix J) testing cannot detect such aging effects (see NRC IN 92-20).

In its response dated May 19, 2004, the applicant stated that Item 3.5.1-3 pertains to carbon steel penetrations which are not susceptible to SCC. Consistent with the GALL Report, this item does not require further evaluation. Item 3.5.1-2 addresses SCC of stainless steel penetration bellows. No bellows are used for piping system containment penetrations. The fuel transfer tube is equipped with bellows-type expansion joints that connect the transfer tube to the liner of the refueling canal in containment and to the liner of the spent fuel pool in the auxiliary building. Tables 2.3.3-1 and 3.3.2-1 identify the fuel transfer tube (assembly). Item 3.5.1-2 applies to the fuel transfer tube sleeve but not to the bellows, since the bellows is not part of the containment penetration boundary.

Furthermore, the applicant explained that the bellows connecting the transfer tube to the refueling canal liner is an extension of the refueling canal liner, which has no license renewal intended function. The bellows on the other end of the transfer tube connects the transfer tube to the liner in the fuel tilt pit portion of the spent fuel pool. The low point of the opening connecting the spent fuel pool to the tilt pit is above the top of the spent fuel stored in the storage racks, so failure of the bellows cannot result in uncovering of the fuel. Therefore, neither bellows attached to the fuel transfer tube performs a license renewal intended function.

Based on the response, the staff understands that ANO-2 has no pressure-retaining bellows (stainless steel or carbon steel) as part of the pressure-retaining containment penetrations. The staff finds the response acceptable, as it adequately justifies not explicitly considering the cracking of containment fuel transfer tube bellows as an aging management item during the extended period of operation. However, as the fuel transfer tube penetration (refer to Table 3.3.2-1) represents containment pressure boundary, the applicant's Water Chemistry Control Program and Containment Inservice Inspection Program will monitor its aging effects.

For seals and gaskets related to containment penetrations, the staff noted that LRA Table 3.5.1, Item 3.5.1-6, gives the Containment Inservice Inspection Program and Containment Leak Rate Testing Program as the AMPs. For equipment hatches and airlocks at ANO-2, the staff agreed with the applicant's assertion that the Leak Rate Testing Program would monitor aging degradation of seals and gaskets, as their leak rate would be tested after each opening. For other penetrations with seals and gaskets, in RAI 3.5-2, the staff asked the applicant to provide information regarding the adequacy of Type B leak rate testing frequency to monitor aging degradation of seals and gaskets at ANO-2.

In its response dated May 19, 2004, the applicant stated that, for ANO-2, the equipment hatch seal listed in Table 3.5.2-4 is the only line item for seals or gaskets that credits the Containment Leak Rate Testing Program. The equipment hatch seal is the only line item that refers to Item 3.5.1-6 of Table 3.5.1.

The staff requested that the applicant provide information regarding the aging management of seals and gaskets for mechanical and electrical penetrations (other than those associated with equipment hatch and airlocks).

By letter dated July 22, 2004, the applicant provided the following additional information to address RAI 3.5-2:

> Gaskets associated with containment mechanical penetrations are consumables that are replaced each time the bolted joint is disassembled. In addition, such penetrations are tested under the containment leak rate program as required by 10 CFR 50, Appendix J. As indicated in LRA Table 3.5.2-1, containment electrical penetrations (which include cable feed-through assemblies) are included in the containment leak rate program. The effects of aging on seals and gaskets associated with mechanical and electrical penetrations are managed by the containment leak rate program. Line item 3.5.1-6 of Table 3.5.1 applies to seals and gaskets associated with mechanical penetrations and electrical penetrations.
>
> ANO-2 is committed to Option B of 10 CFR 50, Appendix J for performing containment leakage rate testing. Option B allows Type B test intervals up to 120 months; however, normally it is performed more frequently than every 120 months. Type B testing of ANO-2 mechanical and electrical penetrations is performed at least once every 120 months. Component specific testing frequency is based on the safety significance and historical performance of the penetrations in accordance with Option B of 10 CFR 50, Appendix J.

The staff found the response acceptable, as it provides adequate details regarding the aging management of pressure boundary seals and gaskets associated with containment electrical and mechanical penetrations.

In its discussion of Item 3.5.12 in Section 3.5.2.2.1.4 of the LRA, the applicant noted that the moisture barrier is monitored under the ASME Code, Subsection IWE, program for aging degradation and, since the conditions described in the GALL Report are met for inaccessible areas (i.e., liner plate), loss of material due to corrosion is insignificant. The industry experience indicates that the moisture barrier degrades with time, and any moisture accumulation in the degraded barrier corrodes the steel liner. The staff requested that the applicant provide information regarding the operating experience related to the degradation of the moisture barrier and the containment liner plate at ANO-2. The staff requested that the applicant discuss acceptable liner plate corrosion before the liner plate would be reinstated to its nominal thickness.

In response, the applicant stated the following:

> The ANO-2 operating experience review did not identify degradation of the moisture barrier and containment liner plate at ANO-2. The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Subsection IWE provides the requirements for ISI of containment structures. The requirements include examination, evaluation, repair, and replacement of the concrete containment liner plate in accordance with 10CFR50.55a. The acceptable thickness for ANO-2 liner plate is determined in accordance with ASME Boiler and Pressure Vessel Code, Section XI, Subsection IWE.

The staff noted that the applicant has not experienced any degradation of the containment moisture barrier and liner, and that the applicant is examining these components pursuant to the requirements of Subsection IWE, as incorporated by reference in 10 CFR 50.55a. The staff finds the condition acceptable, as it provides an assurance that these components will be adequately managed for aging effects during the extended period of operation.

For structural items inside the ANO-2 containment (e.g., primary and secondary shield walls, reactor missile shields, and RV foundation), in Table 3.5.2 of the LRA, the applicant referred to Notes I and 501 to indicate that the temperatures around these components are within the GALL Report threshold, and, therefore, the aging effects (i.e., reduction in concrete strength and modulus of elasticity) do not apply (also discussed, in general, in Section 3.5.2.2.1.3 of the LRA). In this context, in RAI 3.5-4(a), (b) and (c), the staff asked the applicant to provide the following information.

(a) Provide the method(s) of monitoring temperatures within the primary shield wall concrete, around the reactor vessel, and in the reactor cavity.

In response, the applicant stated the following:

> Temperatures within the primary shield wall concrete are not directly monitored. Assurance that bulk concrete temperatures around the reactor vessel within the reactor cavity remain below 150 °F is obtained through maintaining average bulk containment temperature within the limits allowed by ANO-2 Technical Specification 3.6.1.4. Since forced cooling is provided directly to the reactor cavity, its temperature is lower than the bulk average containment temperature. A review of containment temperature readings from near the reactor vessel over the last 12 months, as recorded in the plant data system, show the area temperature has remained below 150 °F.

Based on the above assurances, the staff believes that the concrete properties will not be significantly changed as a result of these temperatures.

(b) If the primary shield wall concrete is kept below the threshold temperature (i.e., 150 °F) by means of air cooling, provide the operating experience related to the performance of the cooling system.

In response, the applicant stated the following:

> The primary shield wall concrete temperature is kept below the threshold temperature by means of air cooling. The operating experience review did not identify significant degradation or system failures. The technical specification requirement on containment temperature provides assurance that plant operation will continue only with satisfactory performance of the containment cooling system.

Based on the assurances provided in response to (a) and (b) above, the staff believes that the concrete properties around the primary shield wall and RPV support structure will not be significantly changed as a result of these temperatures.

(c) Provide the results of the latest inspection of these components, in terms of cracking, spalling, and the condition of reactor vessel support structures.

In response, the applicant stated the following:

> The results of the last inspection of the reactor vessel supports, performed during the spring 1997 refueling outage, identified inactive boron deposits on the support steel. The condition was evaluated under the Boric Acid Corrosion Program and determined to have no effect on the support's ability to perform its intended function. No other conditions were identified.

The Boric Acid Corrosion Program only addresses the conditions affected by boric acid exposure. It cannot, by itself, indicate the condition of the concrete structures. Section X.S6 of the GALL Report recommends the use of ACI 349-3R, as part of the Structures Monitoring Program (as summarized in ANO-2 AMP B.1.27), for identifying and evaluating degradation of concrete structures, including the structures inside containment. Therefore, the staff asked the applicant to provide the information requested in RAI 3.5-4(c) in terms of the criteria established in Chapter 5 of ACI 349-3R.

By letter dated July 22, 2004, the applicant provided the following information to address RAI 3.5-4(c):

> The Structures Monitoring Program is used for evaluation of concrete structures. The evaluation criteria in ACI 349-3R are incorporated in the Structures Monitoring Program. The Structures Monitoring Program provides the same criteria for identifying concrete degradation as ACI-349-3R. During the latest inspection, the concrete of the primary shield wall and the reactor pressure vessel support structure was acceptable without further evaluation in accordance with the criteria of ACI 349-3R, Section 5.1. No cracking or spalling of the primary shield wall or reactor pressure vessel support concrete structures was noted during the inspection.

The staff finds the response acceptable, as the criteria used in Structures Monitoring Program will adequately manage the aging of concrete structures subjected to elevated temperatures.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) can be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.5.2.3.2 Auxiliary Building, Turbine Building, and Yard Structures

Summary of Technical Information in the Application

In Section 3.5.2.1.2 of the LRA, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the auxiliary building, turbine building, and yard structures components:

- Structures Monitoring—Masonry Walls Program (Appendix B.1.26)
- Structures Monitoring Program (Appendix B.1.27)
- Water Chemistry Control Program (Appendix B.1.30)

In Table 3.5.2-2 of the LRA, the applicant provided a summary of AMRs for the auxiliary building, turbine building, and yard structures components and identified which AMRs it considered to be consistent with the GALL Report.

Staff Evaluation

The applicant used the Structures Monitoring—Masonry Wall Program as the AMP for seismic Category I masonry block walls, the Structures Monitoring Program for concrete material (such as building walls, slabs, beams, columns, and foundations) and carbon steel material (such as fuel handling bridge assembly crane rails and girders, high-energy line break doors, and switchyard bus and transformer bus structural supports), and the Water Chemistry Control Program for stainless steel material (such as spent fuel pool liner and bulkhead gates).

On the basis of its review of the LRA, the staff finds that the aging effects on the structural components of the auxiliary building, turbine building, and yard structure with the environments described in Table 3.5.2-2 of the LRA are consistent with industry experience for these combinations of materials and environments. Therefore, the staff finds that the applicant identified the applicable aging effects and associated AMPs that are appropriate for the combinations of materials and environments listed.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) can be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.5.2.3.3 Intake Structure and Emergency Cooling Pond

Summary of Technical Information in the Application

In Section 3.5.2.1.3 of the LRA, the applicant noted that the intake structure and emergency cooling pond (constructed from materials of carbon steel, natural soils, and reinforced concrete and subject to environments of raw water, weather, and protected weather conditions) require management of aging effects of loss of form and loss of material. The applicant credited the following programs to manage the aging effects:

- Service Water Integrity Program (Appendix B.1.24)
- Structural Monitoring Program (Appendix B.1.27)
- Periodic Surveillance and Preventive Maintenance Program (Appendix B.1.18)

In Table 3.5.2-3 of the LRA, the applicant provided a summary of AMRs for the intake structure and emergency cooling pond and identified which AMRs it considered not to be consistent with the GALL Report.

Staff Evaluation

The applicant used the Service Water Integrity Program as the AMP for submerged pump and shaft supports (made of carbon steel) and the emergency cooling pond concrete intake (made of reinforced concrete), the Structures Monitoring Program for concrete material (such as building walls, floor slabs, roof slabs, beams, columns, and foundations) and carbon steel material (such as floor hatches, louvered doors, and beams in service water and circulating water bays), and the Periodic Surveillance and Preventive Maintenance Program for the emergency cooling pond (made of natural soils).

Table 3.5-2-3 indicates that the applicant provided no AMP for the intake canal. The staff issued RAI 3.5-9, which states that the intended function of the intake canal, as listed on Table 3.5.2-3, is to provide structural or functional support to equipment required to meet the Commission's regulations for the five regulated events in 10 CFR 54.4(a)(3). Section 2.4.3 of the LRA states that the intake canal provides a suction source for the fire water and service water pumps. However, the applicant provided no AMP for the intake canal. Therefore, the staff requested that the applicant justify not providing an AMP for the intake canal and explain how the intended function can be met without an AMP.

In its response dated May 19, 2004, the applicant stated the following:

> The intended function of the intake canal can be met without an aging management program because the canal has no aging effects requiring management. As described in ANO-2 SAR Section 2.5.5.1, the seismic stability of the intake canal slope was analyzed. The intake canal is qualified as Seismic Category 1. The intake canal has adequate vegetation and consists of engineered slopes to limit erosion caused by wind. The intake canal was completely excavated and contains no sections formed by dikes or fill. The overburden soils at the site are mainly stiff highly plastic clays. At the intake canal about 13 to 25 feet of clay overlies weathered bedrock. The underlying bedrock consists of dense shale with about two to five feet of weathered shale which prevents erosion of the bed. In addition, since the intake canal was designed with the capacity to supply circulating water to ANO-1, its capacity is far greater than required to provide service water to ANO-2. As a result no aging effects requiring management are identified in Table 3.5.2-3. This is consistent with a previously approved staff position documented in Section 3.3.6.6.2.1 of NUREG-1743, Safety Evaluation Report Related to the License Renewal of

Arkansas Nuclear One—Unit 2.

The staff disagrees with the applicant's assertion that the canal has no AERMs. The applicant's statement that the intake canal is qualified as seismic Category 1 further demonstrates the need for an AMP.

In its response, dated August 18, 2004, the applicant committed to inspect the intake canal periodically as part of the ANO Maintenance Rule program during the period of extended operation. This commitment is acceptable to the staff.

On the basis of its review of the LRA, the staff finds that the aging effects on the structural components of the intake structure, intake canal, and emergency cooling pond with the environments described in Table 3.5.2-3 of the LRA are consistent with industry experience for these combinations of materials and environments. Therefore, the staff finds that applicant identified the applicable aging effects and associated AMPs that are appropriate for the combinations of materials and environments.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) can be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.5.2.3.4 Bulk Commodities

Summary of Technical Information in the Application

In Section 3.5.2.1.4 of the LRA, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the AERMs for the bulk commodities components:

- Fire Protection Program (Appendix B.1.10)
- Inservice Inspection—Inservice Inspection Program (Appendix B.1.14)
- Structures Monitoring Program (Appendix B.1.27)
- Containment Leak Rate Testing Program (Appendix B.1.6)

In Table 3.5.2-4 of the LRA, the applicant provided a summary of AMRs for the bulk commodities components and identified which AMRs it considered to be consistent with the GALL Report.

Staff Evaluation

The applicant used the Fire Protection Program as the AMP for fire doors and fire hose reels (carbon steel), fireproofing (pyrocrete material), and fire barrier seals (elastomers material); the

Inservice Inspection (IWF) Program for base plates, component supports (e.g., instrument racks and frames), main steamline support structure, piping supports, anchor bolts, and RCS component support threaded fasteners (for the steam generator, RCP, pressurizer) which are made of carbon steel; the Structures Monitoring Program for cable tray and conduit supports, embedded unistrut, electrical instrument panels and enclosures, fir damper framing, HVAC missile barrier, monorails, crane rails and girders, pipe sleeves (mechanical/electrical, not penetrating the containment liner plate), pipe whip restraints, stairs, ladders, platforms, grating, anchor bolts in switchyard structures, tank anchors, threaded fasteners, equipment pads, flood curbs, hatch covers and plugs, missile shields, support pedestals, joint elastomers at seismic gaps, and penetration seals; and the Containment Leak Rate Testing Program for equipment hatch seals.

On the basis of its review of the LRA, the staff finds that the aging effects on the structural components of the bulk commodities with the environments described in Table 3.5.2-4 of the LRA are consistent with industry experience for these combinations of materials and environments. Therefore, the staff finds that the applicant identified the applicable aging effects and associated AMPs that are appropriate for the combinations of materials and environments listed.

The staff issued RAI 3.5-5, dated May 19, 2004, given below:

> LRA Section 3.5.2.2.1.1 states that the below-grade environment is not aggressive (pH > 5.5, chlorides < 500 ppm, and sulfates < 1,500 ppm). The applicant is requested to provide the values of pH, chlorides, and sulfates at the plant site and when they were obtained. In III A7.1-e, GALL recommends periodic monitoring of below-grade water chemistry for non-aggressive environments. Since the applicant has made no commitment to periodically monitor the groundwater, the applicant is requested to submit its method for assuring the continuing verification of the non-aggressiveness of the below-grade environment.

The applicant provided the following response:

> The most recent data associated with ANO groundwater chemistry was obtained in May 1996. The results of this analysis are as follows (values obtained near ANO-2 containment):
>
> pH = 7.23
> chlorides < 5 ppm
> sulfates = 20.3 ppm
>
> Comparing this data to that of the ANO-2 SAR Table 2.4-4 (well point 1) and Figure 2.4-1 (well point location), the limiting chemistry parameters have shown no significant increase and are still far from the established limits. The existing data indicates that there has been no significant change in groundwater chemistry since original licensing (a period of approximately 25 years) that would warrant increased monitoring and it is not anticipated to significantly change in the future. Therefore, periodic monitoring of groundwater chemistry is not required to assure the non-aggressiveness of the below-grade environment.

The staff disagrees with the applicant's assertion that periodic monitoring of ground water chemistry is not required to assure the non-aggressiveness of the below-grade environment. Even though ground water chemistry has not changed significantly in the past, the ground water chemistry is not guaranteed to remain the same in the future. Therefore, periodic monitoring of ground water chemistry in the future is needed to assure that ground water chemistry does not change significantly.

The applicant submitted its response, dated August 18, 2004:

> Wells are no longer available for sampling groundwater. Consequently, in lieu of sampling groundwater to confirm that it remains non-aggressive, concrete exposed to groundwater is included in the Structures Monitoring Program for inspection to confirm the absence of aging effects. Under the Structures Monitoring Program, concrete exposed to lake water is periodically inspected. Since lake water chemistry is representative of groundwater chemistry, results of these inspections will be representative of underground concrete exposed to groundwater. In addition, when excavated for maintenance activities, inaccessible concrete exposed to groundwater will be visually inspected under the Structures Monitoring Program.

The applicant's Structures Monitoring program uses inspections of the service water bays as a surrogate for inaccessible concrete exposed to groundwater. At least one service water bay is usually inspected during each outage. The Structures Monitoring program uses these inspections in conjunction with opportunistic inspections to manage the aging effects of inaccessible concrete exposed to groundwater. The staff accepts the applicant's use of the Structures Monitoring Program as an AMP to confirm the absence of concrete aging effects due to ground water.

The staff's RAI 3.5-6, dated May 19, 2004, is given below:

> Item 3.5.1-22 of Table 3.5.1 indicates that the applicant intends to use the Structures Monitoring Program to manage the aging effect for Group 6 structures instead of using the Generic Aging Lessons Learned (GALL) Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC/US Army Corp of Engineers dam inspections and maintenance. The applicant is requested to list the attributes, which are in the GALL but not in the ANO-2 Structures Monitoring Program, and provide justifications for use of the Structures Monitoring Program without those attributes.

In its response dated May 19, 2004, the applicant stated the following:

> Regulatory Guide (RG) 1.127, Inspection of Water-Control Structures associated with Nuclear Power Plants, is identified as XI.S7 Program in GALL for managing

operating experience.

> The attributes that are in the GALL XI.S7 aging management program, but not in the ANO-2 Structures Monitoring Program, are attributes dealing with earthen embankment water control structures. RG 1.127 proposes inspection parameters (e.g., settlement, depressions, sink holes, slope stability (e.g., irregularities in alignment and variances from originally constructed slopes), seepage, proper functioning of drainage systems, and degradation of slope protection features) and frequency (not to exceed 5 years) for earthen embankment water control structures. During the ANO-2 aging management review, the only aging effect requiring management for earthen structures was determined to be loss of form of the emergency cooling pond. Loss of form is effectively managed by sounding under the Periodic Surveillance and Preventive Maintenance Program as indicated in LRA Table 3.5.2-3. Therefore, the attributes of the NUREG-1801 XI.S7 aging management program regarding earthen structures are not necessary attributes for the ANO-2 Structures Monitoring Program for water control structures.

The applicant noted that the loss of form of the emergency cooling pond is the only aging effect that requires an AMP for earthen structures. The staff believes that the intake canal is an earthen water-control structure at ANO-2, which also requires an AMP.

The applicant submitted its response, dated July 22, 2004, and clarified that water-control structures at ANO-2 also include the intake canal. The applicant committed to inspect the intake canal periodically as part of the ANO Maintenance Rule program during the period of extended operation, as documented in Section 3.5.2.3 of this SER.

Since the intake canal is included in the water-control structures and will be periodically inspected, the staff considers the RAI resolved.

The staff's RAI 3.5-7, dated May 19, 2004, is given below:

> Item 3.5.1-23 of Table 3.5.1 indicates that the applicant does not plan to monitor the spent fuel pool water level as stated in the GALL in managing liners for crack initiation and growth due to SCC; loss of material due to crevice corrosion. The applicant is requested to provide justifications for the exclusion of this GALL aging management program.

In its response dated May 19, 2004, the applicant stated the following:

> Monitoring of spent fuel pool level is required by ANO-2 Technical Specification 4.9.10. This activity was not crediting an aging management program because of its very limited scope. As stated in the LRA, the ANO-2 Water Chemistry Program provides effective management of the effects of aging on the spent fuel pool liner.

The staff was unclear about the applicant's statement that monitoring of spent fuel pool level, "was not crediting an aging management program because of its very limited scope." And requested the applicant to explain what was meant by the "very limited scope" and why the monitoring of spent fuel pool water level can not be credited as an AMP.

The applicant submitted its response, dated July 22, 2004, given below:

> The response should have said, "This activity was not credited as an aging management program because of its very limited scope." This was intended to reflect the treatment of spent fuel pool level monitoring in NUREG-1801, which identifies spent fuel pool level monitoring in the aging management program column in Item A5.2 but does not include it in the program descriptions of Section XI of NUREG-1801. Spent fuel pool level monitoring is credited to verify effectiveness of the water chemistry control program to manage the effects of aging on the spent fuel pool liner. At ANO-2 this activity is performed as required by ANO-2 Technical Specification 4.9.10.

Since the applicant has credited the spent fuel pool water level monitoring activity for managing the effects of aging on the spent fuel pool liner, the staff considers the RAI resolved.

The staff's RAI 3.5-8, dated May 19, 2004, is given below:

> Item 3.5.1-33 of Table 3.5.1 indicates that the applicant intends to use inservice inspection (IWF) and Boric Acid Corrosion Prevention Programs to manage the crack initiation and growth due to SCC for high strength low-alloy bolts instead of using the GALL Bolting Integrity Program. The applicant is requested to identify bolts that have actual yield strength equal to or greater than 150 ksi and provide justification for not using the Bolting Integrity Program.

In its response dated May 19, 2004, the applicant stated the following:

> A more appropriate statement for "Discussion" column for item 3.5.1-33 is "This is not an applicable aging effect for ANO-2 structural bolts. This line item is not referenced in the 3.5.2-series table."
>
> The materials used in bolting and threaded structural steel connections within the scope of license renewal are identified in ANO-2 SAR Section 3.8.3.6.2.2. ANO-2 utilizes a limited number of high strength bolts (yield strength >150 ksi) in structural connections. The ANO-2 aging management review identifies loss of material (but not cracking) as the aging effect requiring management for these bolts. Cracking of bolting in an air environment due to SCC has not been observed at ANO-2 and was not identified in a survey of industry experience. For ANO-2 the Inservice Inspection (IWF) and Boric Acid Corrosion Prevention Programs are credited and have been determined to be effective in managing loss of material.

The staff did not understand the applicant's statement that: "This is not an applicable aging effect for ANO-2 structural bolts," since the applicant stated that a limited number of high-strength bolts (i.e., yield strength greater than 150 ksi) were used in structural connections. The staff requested the applicant to provide technical bases for its AMR conclusion that the

SCC is not an aging effect for these high-strength bolts, as well as references to the claim that cracking of bolting in an air environment due to SCC has not been observed in a survey of industry experience.

The applicant submitted its response, dated July 22, 2004, as given below:

> The high strength bolts referred to in the response to RAI 3.5-8 are identified in ANO-2 SAR Section 3.8.3.6.2.2. A more detailed review revealed that these bolts have a yield strength less than 150 ksi. No high strength bolts having a yield strength greater than 150 ksi were used in structural connections at ANO-2. This was confirmed through review of a number of material test reports for ANO-2 high strength bolts.

Since ANO-2 does not contain any bolts having a yield strength greater than 150 ksi, the staff considers the RAI resolved.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) can be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.5.3 Conclusion

On the basis of its review, the staff concludes that the applicant has demonstrated that the aging effects associated with the containments, structures, and component supports will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging of the containments, structures, and component supports, as required by 10 CFR 54.21(d).

3.6 Electrical and Instrumentation and Controls

The applicant described the results of its AMR for electrical and instrumentation and control components subject to an AMR in Section 3.6 of the LRA. The staff reviewed this section of the application to determine whether the applicant has demonstrated that the effect of aging on electric components will be adequately managed during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.1 Summary of Technical Information in the Application

In Section 3.6 of the LRA, the applicant provided the results of the AMR of the electrical and I&C components listed in Table 2.5-1 of the LRA. The applicant also listed the materials, environments, AERMs, and AMPs associated with each commodity group.

In Table 3.6.1 of the LRA, the applicant provided a summary comparison of its AMRs with the AMRs evaluated in the GALL Report for the electrical and I&C components and component types. In Section 3.6.2.2 of the LRA, the applicant provided information concerning Table 3.6.1 components for which the GALL Report recommends further evaluation.

The applicant addressed the following electrical components as commodity groups requiring an AMR:

- insulated cables and connections
- phase bus
- switchyard bus
- high-voltage insulators

The following summarizes the materials, environments, aging effects requiring management, AMPs, and further evaluations of aging management recommended by the GALL Report. Table 3.6.2-1, "Electrical and I&C Components - Summary of Aging Management Evaluation," of the LRA further summarizes the results of the applicant's AMR and provides the NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," comparison for electric components.

- Materials from which electrical components subject to an AMR are constructed include the following:
    - — aluminum
    - — cement
    - — copper and copper alloys
    - — porcelain
    - — steel
    - — organic polymers
    - — galvanized metals
- Environments to which electrical components subject to an AMR are exposed include the following:
    - — borated water leakage

- heat and air
- moisture and voltage stress
- radiation and air
- outdoor weather

- Aging effects associated with electrical components requiring management include the following:

  - loss of circuit continuity
  - reduced insulation resistance

- AMPs for managing the effects of aging on electrical components include the following:

  - Boric Acid Corrosion Prevention Program
  - Non-EQ Inaccessible Medium-Voltage Cable Program
  - Non-EQ Insulated Cables and Connections Program

- The GALL Report recommends further evaluation of aging management for the following:

  - electrical equipment subject to environmental qualification
  - quality assurance for aging management of nonsafety-related components

Appendix B to the LRA describes the AMPs and demonstrates that the identified aging effects will be managed for the period of extended operation. Based on these demonstrations, the applicant concluded that the effects of aging associated with electrical components will be managed such that there is reasonable assurance the intended functions will be maintained consistent with the CLB during the period of extended operation.

3.6.2 Staff Evaluation

In Section 3.6 of the LRA, the applicant describes its AMR for electric components at ANO-2. The staff reviewed Section 3.6 to determine whether the applicant has provided sufficient information to demonstrate that the effects of aging will be adequately managed so that the intended functions of electric components will be maintained consistent with the CLB throughout the period of extended operation, in accordance with the requirement of 10 CFR 54.21(a)(3).

The applicant referenced the GALL Report in its AMR. The staff has previously evaluated the adequacy of the aging management of electric components for license renewal as documented in GALL Report. Thus, the staff did not repeat its review of the matters described in the GALL Report, except to ensure that the material presented in the LRA was applicable, and to verify that the applicant had identified the appropriate programs as described and evaluated in the GALL Report. The staff also reviewed aging management information submitted by the applicant that was different from that in the GALL Report or was not addressed in the GALL Report. Finally, the staff reviewed the proposed FSAR supplement to ensure that it provided an adequate description of the programs credited with managing aging for electric components.

The staff performed an audit to confirm the applicant's claim that certain identified AMPs are consistent with the staff-approved AMPs in the GALL Report. The staff did not repeat its review of the matters described in the GALL Report. However, the staff did verify that the material presented in the LRA applies and that the applicant had identified the appropriate GALL AMRs. Section 3.5.2.1 of this SER summarizes the staff's audit findings.

The staff also audited those items that are consistent with the GALL Report and for which further evaluation is recommended. The staff determined that the applicant performed its further evaluations consistent with the acceptance criteria in Section 3.6.3.2 of the SRP-LR. Section 3.6.2.2 of this SER summarizes the staff's audit findings.

The staff conducted a technical review of the remaining items that were not consistent with the GALL Report. The review included evaluating whether the applicant identified all plausible aging effects and listed the appropriate aging effects for the combinations of materials and environments specified. Section 3.6.2.3 of this SER documents the staff's review findings. Finally, the staff reviewed the proposed FSAR Supplement to ensure that it adequately describes the programs credited with managing aging for electrical components.

Table 3.6-1 below provides a summary of the staff's evaluation of components, aging effects/mechanisms, and AMPs listed in LRA Section 3.6 that are addressed in the GALL Report.

Table 3.6-1 Staff Evaluation Table for ANO-2 Electrical Component Evaluations in the GALL Report

Component Group	Aging Effect/Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Electrical equipment subject to 10 CFR 50.49 EQ requirements (Item Number 3.6.1-1)	Degradation due to various aging mechanisms	Environmental Qualification of Electrical Components	Environmental Qualification of Electrical Components (B.1.8)	TLAA, See Section 4.4 of the SER
Electrical cables and connections not subject to 10 CFR 50.49 EQ requirements (Item Number 3.6.1-2)	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure caused by thermal/ thermoxidative degradation of organic; radiolysis and photolysis (ultraviolet [UV] sensitive materials only) of organic; radiation-induced oxidation; moisture intrusion	Electrical cables and connections not subject to 10 CFR 50.49 EQ requirements	Non-EQ Insulated Cables and Connections (B.1.16)	Consistent with GALL, which recommends no further evaluation (See Section `.3)

Component Group	Aging Effect/Mechanism	AMP in GALL Report	AMP in LRA	Staff Evaluation
Electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirement that are sensitive to reduction in conductor resistance (Item Number 3.6.1-3)	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced IR; electrical failure caused by thermal/thermoxidative degradation of organic; radiation-induced oxidation; moisture intrusion	AMP for electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements	Environmental Qualification of Electrical Components (B.1.8)	Non-GALL Program (See Section 3.6.2.1.4)
Inaccessible medium-voltage (2 kV to 15 kV) cables (e.g., installed in conduit or direct buried) not subject to 10 CFR 50.49 EQ requirements (Item Number 3.6.1-4)	Formation of water trees, localized damage leading to electrical failure (breakdown of insulation); water trees caused by moisture intrusion	AMP for inaccessible medium-voltage cables not subject to 10 CFR 50.49 EQ requirements	Non-EQ Insulated Cables and Connections (B.1.15)	Consistent with GALL, which recommends no further evaluation (See Section 3.6.2.1.2)
Electrical connectors not subject to 10 CFR 50.49 requirements that are exposed to borated water leakage (Item Number 3.6.1-5)	Corrosion of connector contact surfaces caused by intrusion of borated water	Boric Acid Corrosion	Boric Acid Corrosion (B.1.3)	Consistent with GALL, which recommends no further evaluation (See Section 3.0.3.2.1)

The staff's review of the ANO-2 electrical and instrumentation and controls system and associated components followed one of several approaches. One approach, documented in Section 3.6.2.1 of this SER, involves the staff's audit and review of the AMR results for components in the electrical and instrumentation and controls system that the applicant indicated are consistent with the GALL Report and do not require further evaluation. Another approach, documented in Section 3.6.2.2 of this SER, involves the staff's review of the AMR results for components in the electrical and instrumentation and controls system that the applicant indicated are consistent with the GALL Report and for which further evaluation is recommended. A third approach, documented in Section 3.6.2.3 of this SER, involves the staff's technical review of the AMR results for components in the electrical and instrumentation and controls system that the applicant indicated are not consistent with the GALL Report, or are not addressed in the GALL Report. AMPs that are credited to manage or monitor aging effects of the electrical and instrumentation and controls system components are reviewed in Sections 3.0.3.1 and 3.6.2.1 of this SER.

3.6.2.1 AMR Results That Are Consistent with the GALL Report

Summary of Technical Information in the Application

In Section 3.6.2.1 of the LRA, the applicant identified the materials, environments, and AERMs. The applicant identified the following programs that manage the aging effects related to the electrical and I&C components:

- Boric Acid Corrosion Prevention Program
- Non-EQ Inaccessible Medium-Voltage Cable Program
- Non-EQ Insulated Cables and Connections Program

Staff Evaluation

In Table 3.6.2-1 of the LRA, the applicant provided a summary of AMRs for the electrical and I&C components and identified which AMRs it considered to be consistent with the GALL Report. The applicant provided a note for each AMR line item. The notes describe how the information in the tables aligns with the information in the GALL Report. The staff audited those AMRs with notes A through E, which indicate that the AMR was consistent with the GALL Report.

Note A indicates that the AMR line item is consistent with the GALL Report for the component, material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report and the validity of the AMR for the site-specific conditions.

Note B indicates that the AMR line item is consistent with the GALL Report for the component, material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff confirmed that it had reviewed and accepted the identified exceptions to the GALL AMPs. The staff also determined whether the AMP identified by the applicant is consistent with the AMP identified in the GALL Report and whether the AMR is valid for the site-specific conditions.

Note C indicates that the component for the AMR line item is different from, but consistent with, the GALL Report for the material, environment, and aging effect. In addition, the AMP is consistent with the AMP identified by the GALL Report. This note indicates that the applicant could not find a listing of some system components in the GALL Report. However, the applicant identified a different component in the GALL Report that has the same material, environment, aging effect, and AMP as the component that was under review. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the AMR line item of the different component applies to the component under review and whether the AMR is valid for the site-specific conditions.

Note D indicates that the component for the AMR line item is different from, but consistent with, the GALL Report for the material, environment, and aging effect. In addition, the AMP takes some exceptions to the AMP identified in the GALL Report. The staff audited these line items to verify consistency with the GALL Report. The staff determined whether the AMR line item of the different component applies to the component under review. The staff determined that it had reviewed and accepted the identified exceptions to the GALL AMPs. The staff also determined whether the AMP identified by the applicant is consistent with the AMP identified in the GALL Report and whether the AMR is valid for the site-specific conditions.

Note E indicates that the AMR line item is consistent with the GALL Report for the material, environment, and aging effect, but a different AMP is credited. The staff audited these line items to verify consistency with the GALL Report. The staff also determined whether the identified AMP would manage the aging effect consistent with the AMP identified by the GALL Report and whether the AMR is valid for the site-specific conditions.

The staff conducted an audit and review of the LRA and program basis documents, which are available at the applicant's engineering office. The results of the audit and review are documented in the ANO-2 Audit and Review Report. On the basis of its audit and review, the staff finds that the AMR results, which the applicant claimed to be consistent with the GALL Report, are consistent with the AMR results in the GALL Report. Therefore, the staff finds that the applicant identified the applicable aging effects that are appropriate for the combinations of materials and environments listed.

Staff Evaluations Pertaining to Recent Operating Experience and Emerging Issues

Because the GALL Report and SRP-LR were issued in July 2001, these documents do not reflect the most current recommendations for managing certain aging effects that have been the subject of recent operating experience or the topic of an emerging issue. As a result, the staff reviewed the following AMR to determine how the applicant proposed to address these items for license renewal. The staff's evaluations are documented as follows.

3.6.2.1.1 AMR for Electric Connectors not Subject to 10 CFR 50.49 Requirements that are Exposed to Borated Water Leakage

Summary of Technical Information in the Application

The applicant stated in Table 3.6.2-1, "Electrical Components - Summary of Aging Management Evaluation," of the LRA that electric connections exposed to borated water leakage subject to an AMR (a) are constructed of various metals, (b) are exposed to borated water leakage, (c) performs the function of providing electrical connections to specified sections of an electrical circuit to deliver voltage and current or signals, (d) are subject to the aging effect of loss of circuit continuity, and (e) require aging management. The aging effect of loss of circuit continuity (caused by the environment consisting of borated water leakage) was identified as causing loss of capability of providing electrical connections to specified sections of an electrical circuit to deliver voltage, current or signals. The applicant concluded that an environment consisting of exposure to borated water leakage will have the aging effect over time of causing loss of circuit continuity through the various metals from which connections are constructed; therefore, an AMP is required.

Staff Evaluation

The staff agrees that an environment consisting of borated water will have a significant aging effect on various metals (the component parts from which connections are constructed); therefore, an AMP for boric acid corrosion prevention is required. The staff's evaluation of the

AMP for boric acid corrosion prevention is addressed in Section 3.0.3.2.1 of this SER. On the basis of its review, the staff therefore concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

Aging Management Programs

In Section 3.6.2.1 of the LRA, the applicant identified the materials, environments, and aging effects requiring management. The applicant identified the following programs that manage the aging effects requiring management for the electrical and I&C components:

- Boric Acid Corrosion Prevention Program (Appendix B.1.3)
- Non-EQ Inaccessible Medium-Voltage Cable (Appendix B.1.15)
- Non-EQ Insulated Cables and Connectors (Appendix B.1.16)

The staff's evaluation of the AMP for Boric Acid Corrosion Program is addressed in Section 3.0.3.2.1 of this SER. The staff's evaluation for the Non-EQ Inaccessible Medium-Voltage Cable Program and Non-EQ Insulated Cables and Connectors are included in this section of the SER. The applicant also identified the AMP for Environmental Qualification of Electrical Components (B.1.8) as the program to manage electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 requirements that are sensitive to reduction in conductor resistance. This evaluation is contained in this section of the SER. The staff evaluated the AMPs to determine if they are appropriate for managing the identified aging effects. The staff also verified that the UFSAR Supplement adequately describes the program.

3.6.2.1.2 AMP for Inaccessible Medium-Voltage Cables Not Subject to 10 CFR 50.49 EQ Requirements

The Non-EQ Inaccessible Medium-Voltage Cables Program is described in Section B.1.15 of the LRA. The LRA credits this Program with assuring that the intended functions of inaccessible medium-voltage cables exposed to the aging effects of moisture and voltage stress will be maintained consistent with the CLB through the period of extended operation. The staff reviewed the LRA to determine whether the applicant has demonstrated that the Non-EQ Inaccessible Medium-Voltage Cables Program will adequately manage the applicable aging effects throughout the period of extended operation, as required by 10 CFR 54.21(a)(3).

Summary of Technical Information in the Application

The applicant's Non-EQ Inaccessible Medium-Voltage Cables Program is discussed in LRA Section B.1.15, "Non-EQ Inaccessible Medium-Voltage Cable." The applicant states that their program will be consistent with the program described in the GALL Report, Section XI.E3, "Inaccessible Medium-Voltage Cables not Subject to 10CFR50.49 Environmental Qualification

Requirements." In this aging management program, the applicant indicates that periodic actions will be taken to prevent cables from being exposed to significant moisture, such as inspecting for water collection in cable manholes and conduit, and draining water, as needed. In-scope medium-voltage cables exposed to significant moisture and voltage will be tested to provide an indication of the condition of the conductor insulation. The specific type of test performed will be determined prior to the initial test.

The applicant describes the program as a new program that will be effective for managing aging effects since it will incorporate appropriate monitoring techniques. The Non-EQ Inaccessible Medium-Voltage Cable Program will provide reasonable assurance that the effects of aging will be managed such that the applicable components will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation. The program will be initiated prior to the period of extended operation.

The applicant's proposed FSAR supplement for the Non-EQ Inaccessible Medium-Voltage Cables Program is discussed in LRA Section A.2.1.16. The applicant states that this program will apply to inaccessible (e.g., in conduit or direct buried) medium-voltage cables within the scope of license renewal that are exposed to significant moisture simultaneously with applied voltage. In this aging management program, periodic actions will be taken to prevent cables from being exposed to significant moisture. In-scope medium-voltage cables exposed to significant moisture and voltage will be tested to provide an indication of the condition of the conductor insulation. The specific type of test performed will be determined prior to the initial test. The Non-EQ Inaccessible Medium-voltage Cable Program will be initiated prior to the period of extended operation.

Staff Evaluation

In LRA Section B.1.15, "Non-EQ Inaccessible Medium-Voltage Cable," the applicant discusses its proposed program for managing the aging effects from moisture and voltage stress. The LRA states that this program will be consistent with the GALL Report Section XI.E3 and will be initiated prior to the period of extended operation.

Based on the applicant's statement that their proposed program for managing the effects of aging will be consistent with the GALL Report Section XI.E1, the staff concludes, pursuant with the GALL Report guidelines, that no further evaluation is needed. The applicant has, therefore, demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3). On the basis of its review, the staff finds that the AMP credited in the LRA for the inaccessible medium-voltage cables not subject to 10 CFR 50.49 EQ requirements will effectively manage or monitor the aging effects identified in the LRA.

Section A.2.1.16 of the LRA contains the applicant's FSAR supplement for the Non-EQ Inaccessible Medium-Voltage Cable Program. The staff reviewed this section and finds the program description is consistent with the material contained in Section B.1.15 of the LRA The staff finds that the FSAR supplement provides an adequate summary of the program activities as required by 10 CFR 54.21(d).

Conclusions

Based on the statement that their proposed program for managing aging effects will be consistent with the GALL Report Section XI.E3, the staff concludes that no further evaluation is needed. The applicant has, therefore, demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3). The staff also reviewed the FSAR supplement for this AMP and finds that it provides an adequate summary description of the program, as required by 10 CFR 54.21(d).

3.6.2.1.3 AMP for Electric Cables and Connections Not Subject to 10 CFR 50.49 EQ Requirements

The Non-EQ Insulated Cables and Connections Program is described in Section B.1.16 of the LRA. The LRA credits this program with assuring that the intended functions of insulated cables and connections will be maintained consistent with the CLB through the period of extended operation. The program monitors and assesses the condition of cables and connections that are affected by adverse localized environments. If an unacceptable condition or situation is identified, a determination is made as to whether the same condition or situation is applicable to other accessible or inaccessible cables and connections. The staff reviewed the LRA to determine whether the applicant has demonstrated that the Non-EQ Insulated Cables and Connections Program will adequately manage the applicable aging effects throughout the period of extended operation, as required by 10 CFR 54.21(a)(3).

Summary of Technical Information in the Application

The applicant's Non-EQ Insulated Cables and Connections Program is discussed in LRA Section B.1.16, "Non-EQ Insulated Cables and Connections." The applicant states that their program will be consistent with the program described in the GALL Report, Section XI.E1, "Electrical Cables and Connections Not Subject to 10CFR50.49 Environmental Qualification Requirements". The applicant describes the program as a new program that will provide reasonable assurance that the intended functions of insulated cables and connections can be maintained consistent with the current licensing basis through the period of extended operation. The program will be effective for managing aging effects since it will incorporate proven monitoring techniques, acceptance criteria, corrective actions, and administrative controls. The program will provide reasonable assurance that the effects of aging will be managed such that the applicable components will continue to perform their intended functions consistent with the current licensing basis for the period of extended operation. And the program will be initiated prior to the period of extended operation.

The applicant's proposed FSAR supplement for Non-EQ Insulated Cables and Connections Program is discussed in LRA Section A.2.1.17. The applicant states that this program will apply to accessible (i.e., able to be approached and viewed easily) insulated cables and connections installed in structures within the scope of license renewal and prone to adverse localized environments. The program will visually inspect a representative sample of accessible insulated cables and connections for cable and connection jacket surface anomalies. The program will be initiated prior to the period of extended operation.

Staff Evaluation

In LRA Section B.1.16, "Non-EQ Insulated Cables and Connections," the applicant discusses its proposed program for managing aging effect due to exposure to heat (or radiation and air). The LRA states that this program will be consistent with GALL AMP XI.E1, "Electrical Cables and Connections," and will be initiated prior to the period of extended operation.

Based on the statement that their proposed program for managing the effects of aging will be consistent with GALL AMP X!.E1, the staff concludes, pursuant with GALL Report guidelines, that no further evaluation is needed. The applicant has, therefore, demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3).

Section A.2.1.17 of Appendix A to the LRA contains the applicant's FSAR supplement for the Non-EQ Insulated Cables and Connections Program. The staff reviewed this section and finds the program description is consistent with the material contained in Section B.1.16 of Appendix B to the LRA. The staff finds that the FSAR supplement provides an adequate summary of the program activities as required by 10 CFR 54.21(d).

Conclusions

Based on the statement that their proposed program for managing aging effects will be consistent with GALL AMP X!.E1, the staff concludes that no further evaluation is needed. The applicant has, therefore, demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3). The staff also reviewed the FSAR supplement for this AMP and finds that it provides an adequate summary description of the program, as required by 10 CFR 54.21(d) .

3.6.2.1.4 AMP for Electrical Cables Used in Instrumentation Circuits Not Subject to 10 CFR50.49 Environmental Qualification Requirement that are Sensitive to Reduction in Conductor Insulation Resistance

The AMP for instrumentation cables that are sensitive to reduction in conductor insulation resistance is described in Section B.1.8 of the LRA. The LRA credits the ANO-2 EQ Program, i.e., the AMP described in Section B.1.8 of the LRA, with assuring that the intended functions of instrumentation cables (that are sensitive to reduction in conductor insulation) will be maintained consistent with the CLB through the period of extended operation. The staff reviewed the LRA to determine whether the applicant has demonstrated that the ANO-2 EQ Program will adequately manage the applicable aging effects throughout the period of extended operation, as required by 10 CFR 54.21(a)(3).

Summary of Technical Information in the Application

Table 3.6.1 of the LRA states that the aging management program evaluated as part of the GALL Report (for electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements that are sensitive to reduction in conductor insulation resistance) is not applicable to ANO-2. The aging management program is not applicable since ANO-2 instrumentation cables for high range radiation monitors and neutron flux detectors are subject to 10 CFR 50.49 environmental qualification (EQ) requirements.

Staff Evaluation

From the information presented in the LRA, the staff understands that instrumentation cables used for high range radiation monitors and neutron flux detectors (that are sensitive to reduction in conductor insulation resistance) will be subject the AMP defined by ANO-2's EQ program which meets the requirements of 10 CFR 50.49. 10 CFR 50.49(c)(3), however, states that environmental qualification of electric equipment important to safety located in a mild environment are not included within the scope of 10 CFR 50.49; thus, these instrumentation cables that are located in a mild environment (or not exposed to harsh environments) are not explicitly required to be within the scope of 10 CFR 50.49. Based on its review, the staff concludes, as described in section 4.4 of this SER, that a plant's EQ program (which meets the requirements of 10 CFR 50.49) is an acceptable AMP for license renewal. Therefore, subject to a commitment (included as part of proposed FSAR supplement A.2.1.8 of the LRA), the staff concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3).

Conclusions

Based on its review, the staff concludes, subject to an FSAR commitment that the subject instrumentation circuits are within the scope of 10 CFR 50.49, that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation as required by 10 CFR 54.21(a)(3).

3.6.2.1.5 Conclusion

The staff has evaluated the applicant's claim of consistency with the GALL Report. The staff also reviewed information pertaining to the applicant's consideration of recent operating experience and proposals for managing associated aging effects. On the basis of its review, the staff finds that the applicant has demonstrated that the effects of aging for these components will be adequately managed, so that their intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.2.2 Aging Management Evaluations That Are Consistent with the GALL Report, for Which Further Evaluation Is Recommended

Summary of Technical Information in the Application

In Section 3.6.2.2 of the LRA, the applicant provided further evaluation of aging management as recommended by the GALL Report for electrical and I&C components. The applicant provided information concerning how it will manage the following aging effects:

- electrical equipment subject to environmental qualification
- quality assurance for aging management of nonsafety-related components

Staff Evaluation

For component groups for which GALL recommends further evaluation, the staff reviewed the applicant's evaluation to determine whether it adequately addressed the issues for which GALL recommended further evaluation.

3.6.2.2.1 Environmental Qualification (EQ) of Electrical Components

The aging analysis included as part of an environmental qualification program, which meets the requirements of 10 CFR 50.49 that involve time-limited assumptions as defined by the current operating term for the ANO-2 (i.e., 40 years), is a TLAA as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c)(1). The staff's review of the environmental qualification program as a TLAA for license renewal is described in Section 4.4 of this SER.

3.6.2.2.2 Quality Assurance for Aging Management of Nonsafety-Related Components

The staff's review of quality assurance for aging management of non-safety-related electric components is included as part of Section 3.0.4, "Quality Assurance Program Attributes Integral to Aging Management Programs," of this SER.

In addition, the staff reviewed the applicant's further evaluations against the criteria contained in Section 3.6.3.2 of the SRP-LR. The ANO-2 audit and review report documents the details of the staff's audit and review.

Conclusion

On the basis of its audit and review, the staff finds that the applicant's further evaluations conducted in accordance with the GALL Report are consistent with the acceptance criteria in Section 3.6.3.2 of the SRP-LR. Since the applicant's AMR results are otherwise consistent with the GALL report, the staff finds that the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) can be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.2.3 AMR Results That Are Not Consistent with the GALL Report or Not Addressed in the GALL Report

The applicant described the results of its AMR for electrical components in Table 3.6.2-1 of the LRA. The staff reviewed these results to determine whether the applicant has demonstrated that the effect of aging on the electrical components will be adequately managed during the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.2.3.1 Phase Bus (Nonsegregated Bus for Station Blackout) and Connections

Summary of Technical Information in the Application

The applicant stated in Table 3.6.2-1 of the LRA that phase bus and connections subject to an AMR (1) are constructed of aluminum, copper, and steel, (2) are exposed to heat and air, or an outside weather environment consisting of temperatures up to 40 °C (105 °F), precipitation, and negligible radiation, (3) are exposed to an ohmic heating environment consisting of temperatures up to 72 °C (162 °F), (4) provide electrical connections to specified sections of an electrical circuit to deliver voltage and current, and (5) require no AMP. The applicant did not identify any aging effects from the environment (consisting of heat and air, or outside weather up to 40 °C (105 °F), ohmic heating and air up to 72 °C (162 °F), and precipitation) that would cause the loss of capability to provide electrical connections to specified sections of an electrical circuit to deliver voltage, current, or signals. The applicant concluded that an environment consisting of temperatures up to 40 °C (105 °F), ohmic heat and air up to 72 °C (162 °F), and precipitation has no significant aging effect on aluminum, copper, and steel (the component parts from which the phase bus and connections are constructed); therefore, no AMP is required.

Staff Evaluation

The staff agrees that an environment consisting of temperatures up to 40 °C (105 °F), ohmic heat and air up to 72 °C (162 °F), and precipitation has no significant aging effect on aluminum, copper, and steel (the component parts from which phase bus and connections are constructed); therefore, no AMP is required.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.6.2.3.2 Switchyard Bus (Switchyard Bus for Station Blackout) and Connections

Summary of Technical Information in the Application

The applicant stated in Table 3.6.2-1 of the LRA that switchyard bus and connections subject to an AMR (1) are constructed of aluminum and copper, (2) are exposed to an outdoor weather environment consisting of temperatures up to 40 °C (105 °F), precipitation, and negligible radiation, (3) provide electrical connections to specified sections of an electrical circuit to deliver voltage, current, or signals, and (4) require no AMP. The applicant did not identify any aging effects from the outdoor environment (consisting of temperatures up to 40 °C (105 °F) and precipitation) that would cause the loss of the capability to provide electrical connections to specified sections of an electrical circuit to deliver voltage, current, or signals. The applicant concluded that an environment consisting of temperatures up to 40 °C (105 °F) and precipitation has no significant aging effect on aluminum and copper (the component parts from which switchyard bus and connections are constructed); therefore, no AMP is required.

Staff Evaluation

The staff agrees that an outdoor weather environment has no significant aging effect on aluminum and copper (the component parts from which switchyard bus and connections are constructed); therefore, no AMP is required.

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.6.2.3.3 High-Voltage Insulators

Summary of Technical Information in the Application

The applicant stated in Table 3.6.2-1 of the LRA that high-voltage insulators subject to an AMR (1) are constructed of porcelain, galvanized metal, and cement, (2) are exposed to an outdoor weather environment consisting of temperatures up to 40 °C (105 °F), precipitation, and negligible radiation, (3) insulate and support an electrical conductor, and (4) require no AMP. The applicant did not identify any aging effects from the outside environment (consisting of temperatures up to 40 °C (105 °F) and precipitation) that would cause the loss of the capability to insulate or support its associated electrical conductor. The applicant concluded that an environment consisting of temperatures up to 40 °C (105 °F) and precipitation has no significant aging effect on porcelain, galvanized metal, and cement (the component parts from which high-voltage insulators are constructed); therefore, no AMP is required.

Subsequently, in a letter dated August 18, 2004, the applicant, as part of an additional response to RAI 2.5-1(c) included in Section 3.6.2.3.7.1 of this SE, indicated that high voltage strain and suspension insulators that perform the function of insulating and supporting electrical transmission conductors, like high voltage insulator that perform the function of insulating and supporting switchyard bus described above, are within the scope of license renewal and subject to an AMR. The applicant concluded that an environment consisting of temperatures up to 105°F and precipitation (including wind) has no significant aging effect on porcelain, galvanized metal, and cement (the component parts from which high voltage insulators are constructed); therefore, no aging management program is required.

Staff Evaluation

The staff agrees that an outdoor weather environment has no significant aging effect on porcelain, galvanized metal, and cement (the component parts from which high-voltage insulators are constructed); therefore, no AMP is required. On the basis of its review, the staff therefore concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging can be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in these components, as required by 10 CFR 54.21(d).

3.6.2.3.4 Transmission Conductors

Summary of Technical Information in the Application

By letter dated August 18, 2004, the applicant in a revised response to RAI 2.5-1(c) states:

> Based on the inclusion of Startup Transformer #2, transmission conductors, strain and suspension insulators, and insulated cables are subject to aging management review. Insulated cables were included in the ANO-2 LRA.
>
> The transmission conductor component type includes transmission conductors and the hardware used to secure the conductors to the insulators. The materials for aluminum cable-steel reinforced (ACSR) transmission conductors are aluminum and steel, and the environment is outdoor weather. Based on industry guidance, potential aging effects and aging mechanisms are loss of conductor strength due to general corrosion (atmospheric oxidation of metals) and loss of material due to wear from wind loading.
>
> Corrosion in ACSR conductors is a very slow acting mechanism. Corrosion rates are dependent on air quality. ANO is located in a mostly agricultural area with no significant nearby industries that could contribute to corrosive air quality. Corrosion testing of transmission conductors at Ontario Hydroelectric showed a 30 percent loss of composite conductor strength of an 80-year-old ACSR conductor. The Institute of Electrical and Electronic Engineers National Electrical Safety Code (NESC) requires that tension on installed conductors be a maximum of 60% of the ultimate conductor strength. Therefore, assuming a 30% loss of strength, there would still be significant margin between what is required by the NESC and the actual conductor strength. In determining actual conductor tension, the NESC considers various loads imposed by ice, wind, and

temperature as well as length of conductor span. The transmission conductors in scope for license renewal are short spans located within the high voltage switchyard. The maximum span for ANO conductors subject to aging management review is approximately 240 feet in length providing significant margin to maximum design loading limits. ANO is in the medium loading zone; therefore, the Ontario Hydroelectric heavy loading zone study is conservative with respect to loads imposed by weather conditions.

The Ontario Hydroelectric test envelops the conductors at ANO, demonstrating that the material loss on the ANO ACSR transmission conductors is acceptable for the period of extended operation. This illustrates with reasonable assurance that transmission conductors at ANO will have ample strength to perform their intended function throughout the renewal term; therefore, loss of conductor strength due to corrosion of the transmission conductors is not an aging effect requiring management.

Loss of material due to mechanical wear can be an aging effect for strain and suspension insulators that are subject to movement. Experience has shown that transmission conductors do not normally swing and that when they do swing because of substantial wind, they do not continue to swing for very long once the wind has subsided. Wear has not been identified during routine inspection. Therefore, loss of material due to wear is not an aging effect requiring management for switchyard insulators.

Entergy reviewed industry operating experience and NRC generic communications related to the aging of transmission conductors in order to ensure that no additional aging effects exist beyond those identified above. Entergy also reviewed ANO plant-specific operating experience, including nonconformance reports, licensee event reports, and condition reports, and documented interviews with transmission engineering personnel. Entergy's review did not identify unique aging effects for transmission conductors beyond those identified above.

Staff Evaluation

The staff agrees that an outdoor weather environment has no significant aging effect on aluminum and steel (the component parts from which transmission conductors are constructed); therefore, no aging management program is required. On the basis of its review, the staff therefore concludes that the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

Conclusion

On the basis of its review, the staff finds the applicant has demonstrated that the effects of aging will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

3.6.2.3.5 Inaccessible Medium-Voltage Cables

During the site inspection that was conducted by the staff on November 15 through 19, 2004, a walk-down of the electrical manholes was conducted. The staff noted that all of the observed electrical manholes containing inaccessible medium-voltage cables were flooded, such that the electrical cables in those manholes were submerged. The applicant stated that the program for managing the aging of cables was not yet developed, but would be consistent with Generic Aging Lessons Learned, and included a periodic inspection of the electrical manholes and the removal of water. The staff noted that the cables had been wetted for an indeterminate period of time and requested that the applicant commit to cable testing in addition to periodic inspections for the period of extended operation. In a letter dated February 28, 2005, the applicant added a testing requirement to the AMP for inaccessible medium-voltage cables.

3.6.3 Conclusion

On the basis of its review, the staff concludes that the applicant has demonstrated that the aging effects associated with the electrical components will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3).

The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMPs credited for managing aging in the electrical components, as required by 10 CFR 54.21(d).

3.7 Conclusion for Aging Management

The staff has reviewed the information in Section 3, "Aging Management Review Results," and Appendix B, "Aging Management Programs and Activities" of the LRA. On the basis of its review of the AMR results and AMPs, the staff concludes that the applicant has demonstrated that the aging effects will be adequately managed so that the intended functions will be maintained consistent with the CLB for the period of extended operation, as required by 10 CFR 54.21(a)(3). The staff also reviewed the applicable FSAR Supplement program summaries and concludes that the FSAR Supplement adequately describes the AMP's credited for managing aging, as required by 10 CFR 54.21(d).

With regard to these matters, the NRC staff has concluded that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis, and that any changes made to the ANO-2 current licensing basis in order to comply with 10 CFR 54.21(a)(3) are in accord with the ACT and the Commission's regulations.

4. TIME-LIMITED AGING ANALYSES

4.1 Identification of Time-Limited Aging Analyses

This section addresses the identification of time-limited aging analyses (TLAAs). The applicant discussed the TLAAs in license renewal application (LRA) Sections 4.2 through 4.7. The Nuclear Regulatory Commission (NRC) staff documents its review of the TLAAs in Sections 4.2 through 4.7 of this safety evaluation report (SER).

The TLAAs are certain plant-specific safety analyses that are based on an explicitly assumed 40-year plant life. Pursuant to Title 10, Section 54.21(c)(1), of the *Code of Federal Regulations* (10 CFR 54.21(c)(1)), an applicant for license renewal must provide a list of TLAAs, as defined in 10 CFR 54.3.

In addition, pursuant to 10 CFR 54.21(c)(2), an applicant must provide a list of plant-specific exemptions granted under 10 CFR 50.12 that are based on TLAAs. For any such exemption, the applicant must provide an evaluation that justifies the continuation of the exemptions for the period of extended operation.

4.1.1 Summary of Technical Information in the Application

The applicant evaluated calculations for Arkansas Nuclear One, Unit 2 (ANO-2), against the six criteria specified in 10 CFR 54.3 to identify the TLAAs. The applicant indicated that it identified the calculations that meet the six criteria by searching the current licensing basis (CLB), which includes the Final Safety Analysis Report (FSAR); design-basis documents; the Statements of Consideration for 10 CFR Part 54; NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," (SRP-LR), issued July 2001; and Nuclear Energy Institute (NEI) 95-10, Revision 3, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54—The License Renewal Rule," issued March 2001. The applicant listed the following TLAAs that apply to ANO-2 in Table 4.1-2 of the LRA:

- reactor vessel neutron embrittlement
- concrete containment tendon prestress
- metal fatigue
- environmental qualification of electrical equipment
- high-energy line break postulation based on fatigue cumulative usage factor
- low-temperature overpressure protection analyses
- fatigue analysis for the main steam supply lines to the turbine-driven auxiliary feedwater lines
- leak before break

- fatigue analysis of the containment liner plate
- containment penetration pressurization cycles

Pursuant to 10 CFR 54.21(c)(2), the applicant stated that it identified no exemptions granted under 10 CFR 50.12 that were based on a TLAA, as defined in 10 CFR 54.3.

4.1.2 Staff Evaluation

In LRA Section 4.1, the applicant identified the TLAAs applicable to ANO-2 and discussed exemptions based on TLAAs. The staff reviewed the information to determine whether the applicant provided adequate information to meet the requirements of 10 CFR 54.21(c)(1) and 10 CFR 54.21(c)(2).

Title 10, Section 54.3, of the *Code of Federal Regulations* (10 CFR 54.3) defines TLAAs as analyses that meet the following six criteria:

- involve structures, systems, and components (SSCs) within the scope of license renewal, as delineated in 10 CFR 54.4(a)
- consider the effects of aging
- involve time-limited assumptions defined by the current operating term (e.g., 40 years)
- were determined by the applicant to be relevant in making a safety determination
- involve conclusions, or provide the basis for conclusions, related to the capability of the SSC to perform its intended functions, as delineated in 10 CFR 54.4(b)
- are contained or incorporated by reference in the CLB

The applicant provided a list of common TLAAs from the SRP-LR and those TLAAs that are applicable to ANO-2 in LRA Table 4.1-2.

Pursuant to 10 CFR 54.21(c)(2), an applicant must provide a list of all exemptions granted under 10 CFR 50.12 which it determines to be based on a TLAA and evaluates and justifies for continuation through the period of extended operation. In its LRA, the applicant stated that it performed a search of the ANO-2 docketed correspondence, the operating licenses, and the FSAR, and that it evaluated each exemption in effect for TLAA applicability. The applicant identified no TLAA-based exemptions. On the basis of the information the applicant provided regarding the process it used to identify TLAA-based exemptions, plus the results of the applicant's search, the staff finds that the applicant has found no TLAA-based exemptions which would require justification for continuation through the period of extended operation to satisfy 10 CFR 54.21(c)(2).

4.1.3 Conclusions

On the basis of its review, the staff concludes that the applicant has provided an acceptable list of TLAAs, as required by 10 CFR 54.21(c)(1), and has confirmed that no 10 CFR 50.12 exemptions have been granted on the basis of a TLAA, as required by 10 CFR 54.21(c)(2). The staff notes that the applicant did not initially identify the reactor coolant pump (RCP) flywheel as subject to a TLAA, but included a TLAA for it in response to RAI 4.7.3-1.

4.2 Reactor Vessel Neutron Embrittlement

The following regulations in 10 CFR Part 50 govern reactor vessel (RV) integrity:

- Section 50.60 requires that all light-water reactors (LWRs) meet the fracture toughness, pressure-temperature limits, and material surveillance program requirements for the reactor coolant boundary as set forth in Appendices G and H to 10 CFR Part 50.

- Section 50.61 contains fracture toughness requirements for protection against pressurized thermal shock.

The design bases of ANO-2 contain calculations and analyses addressing the effects of neutron irradiation embrittlement of the RV. The analyses that evaluated the reduction of fracture toughness of the ANO-2 RV for 40 years are TLAAs. The applicant updated the analyses for the initial 40-year license to address the additional 20 years of operation (i.e., 60 years total) for license renewal. The ANO-2 Reactor Vessel Integrity Program described in Appendix B to the LRA will ensure that the time-dependent parameters used in the TLAAs and described below remain valid through the period of extended operation. The applicant projected the RV neutron embrittlement TLAAs to the end of the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii), as summarized below.

The application included three TLAAs for evaluation of the RV beltline materials, including (1) calculation of the end of extended license Charpy V-notch upper-shelf energy (USE) values for each beltline material, (2) calculation of the end of extended license pressurized thermal shock (PTS) reference temperature (RT) value (i.e., RT_{PTS} values) for each beltline material, and (3) a description of the pressure-temperature (P-T) limit calculations for 48 effective full-power years (EFPYs). The applicant will prepare revised P-T limit curves for extended operation and submit them before reaching 32 EFPYs (as stated in Section 5.2.4.3.2 of the Final Safety Analysis Report (FSAR) Supplement). Each analysis has been updated to consider 20 years of additional plant operation. The TLAAs take into account the effects of the additional extended operating period neutron irradiation on the previous calculated end of license USE, RT_{PTS}, and P-T limit values for the RV at ANO-2, and they base the evaluations through 48 EFPYs of power operation.

The applicant assumed a capacity factor of 80 percent for the TLAA associated with RV neutron embrittlement evaluations that it described in Section 4.2 of the LRA. The applicant based these evaluations on end of life (EOL) fluences corresponding to 48 EFPYs of operation. In Request for Additional Information (RAI) 4.2-1, the staff asked the applicant to justify the assumed 80-percent capacity factor for the period of extended operation, in light of similar plants achieving and projecting capacity factors of 90 percent or greater. The staff also requested that the applicant justify the estimated 48-EFPY fluence for ANO-2, or, if the applicant cannot justify a 48-EFPY fluence, it should provide the results of revised evaluations of USE for higher levels of fluence projected to the end of the period of extended operation.

In response to RAI 4.2-1, the applicant stated that the ANO-2 end of license fluence estimate for the period of extended operation is based on 48 EFPYs, which assumes a plant capacity factor of 80 percent over 60 years. This is consistent with the method used to calculate 40-year fluence estimates the applicant reported in its response to Generic Letter 92-01. At present, the lifetime capacity factor for ANO-2 through 26 years of operation is approximately 80 percent. Therefore, it is reasonable to assume a lifetime capacity factor of 80 percent when evaluating 60 years of operation.

The applicant also stated that the Reactor Vessel Integrity Program addresses the impact on fracture toughness of operation at capacity factors in excess of 80 percent. As the applicant stated in Section 4.2 of the LRA, the ANO-2 Reactor Vessel Integrity Program described in Appendix B to the LRA will ensure that the time-dependent parameters (e.g., end of license fluence) used in the TLAA remain valid through the period of extended operation. As capsules are pulled and tested, the applicant will perform fluence updates and end of license vessel fluence extrapolations. The applicant will compare the updated fluence projections to the 48-EFPY fluence estimates reported in the LRA. If the revised end of license fluence extrapolations exceed the values provided in the LRA, then the applicant will update the corresponding fracture toughness parameters (adjusted reference temperature (ART), USE, and RT_{PTS}) accordingly. The staff finds the response acceptable and considers this issue closed.

4.2.1 Charpy Upper-Shelf Energy

Appendix G to 10 CFR Part 50 requires that RV beltline materials must have USE values in the transverse direction for the base metal, and along the weld for the weld material, according to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (the ASME Code) of no less than 75 foot-pounds (ft-lb) (102 J) initially, and USE values throughout the life of the vessel of no less than 50 ft-lb (68 J). However, USE values below these criteria may be acceptable if the applicant demonstrates, in a manner approved by the Director of the Office of Nuclear Reactor Regulation, that the lower values of USE will provide margins of safety against fracture equivalent to those required by Appendix G to Section XI of the ASME Code. Regulatory Guide (RG) 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials," provides an expanded discussion regarding the calculations of USE values and describes two methods for determining USE values for RV beltline materials, depending on if a given RV beltline material is represented in the plant's RV material surveillance program (i.e., Appendix H to 10 CFR Part 50).

4.2.1.1 Summary of Technical Information in the Application

Section 4.2.1 of the LRA addresses the requirement that RV beltline materials must maintain a USE value of not less than 50 ft-lb throughout the life of the vessel, unless the applicant demonstrates, in a manner approved by the Director of the Office of Nuclear Reactor Regulation, that lower values of USE will provide margins of safety against fracture that are equivalent to those required by Appendix G to Section XI of the ASME Code. The applicant stated that it calculated the USE values through the period of extended operation using guidance from RG 1.99, Revision 2. The applicant used a value of 48 EFPYs as the end of extended license criterion for the RV. The LRA contains the information derived from the USE analysis. The applicant summarized the end of extended operating period USE analyses for the ANO-2 RV beltline materials in Table 4.2-1 of the LRA. The LRA includes a list of all beltline materials, the weight percent copper in the steel, the end of license fluence for the RV located one-quarter of the way through the RV wall from the vessel's inside surface (i.e., 1/4 thickness (T) of the vessel), and the initial and final USE values.

The applicant calculated the best estimate fluence at the inside (wetted) surface of the RV using the methodology reported in the Babcock & Wilcox report BAW-2241P-A, Revision 1, "Fluence and Uncertainty Methodologies," issued April 1999. The NRC's Division of Systems, Safety, and Analysis staff approved this methodology, which meets the uncertainty requirements of RG 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence," issued March 2001.

The applicant concluded that the end of extended license USE results for 48 EFPYs are above the screening criterion of 50 ft-lb (68 J). The applicant stated that it projected the calculations through the period of extended operation, and met the requirements of 10 CFR 54.21(c)(1)(ii).

4.2.1.2 Staff Evaluation

The technical staff reviewed the TLAA for USE to identify aspects of the TLAA that are impacted by the additional fluence levels that will occur during the period of extended operation. The review included an independent evaluation of material chemistries and properties, as listed in the NRC's Reactor Vessel Integrity Database (RVID), for consistency with the data listed in the LRA.

The staff performed an independent calculation of the end of extended license USE values for the beltline materials the applicant used to fabricate the ANO-2 RV. The staff applied Position 1.2 of RG 1.99 to estimate the percent loss of USE as a function of copper content and neutron fluence for the beltline materials, as evaluated using the 48-EFPY end of extended license fluence.

With regard to the staff's independent USE analysis of ANO-2 beltline materials, the staff confirmed that the most limiting beltline material it identified for the ANO-2 RV is the same as that identified by the applicant. Although the staff's calculated USE values for the limiting RV beltline materials were not always consistent with the applicant's calculated USE values, both the staff's and the applicant's USE analyses confirm that the USE values for the ANO-2 beltline materials will remain at or above the 50 ft-lb acceptance criteria of Appendix G to 10 CFR Part 50 through the expiration of the period of extended operation for the unit.

The staff determined that the 48-EFPY (60-year) USE assessment for the RV beltline materials is bounded (limited) by the USE value for the intermediate shell longitudinal weld 2-203 A. The staff calculated the projected USE value for this material to be 54 ft-lb through the expiration of the period of extended operation for the unit. This material meets the staff's end of license 50 ft-lb acceptance criterion for USE. The staff also performed a 54 EFPY USE assessment for the ANO-2 RV beltline materials and calculated a limiting USE of 52.5 ft-lb through the expiration of the period of extended operation.[4]

[4] Although the design basis used in the LRA for the period of extended operation is 48 EFPY, the staff also performed additional USE calculations for the RV beltline materials at 54 EFPY. The staff performed the additional calculations to resolve a question raised by the Advisory Committee on Reactor Safety (ACRS) during the ACRS Subcommittee meeting on the ANO-2 LRA. The staff calculated the limiting USE value to be 52.5 ft-lb at 54 EFPY. The staff's acceptance criterion on USE, as stated in 10 CFR Part 50, Appendix G, is a minimum of 50 ft-lb at the end of licensed life of the reactor. Thus, the ANO-2 RV will acceptable for USE even if an addition 6 EFPY is added to the 48 EFPY design basis for the period of extended operation.

The applicant did not include upper/intermediate shell weld 8-203 in Table 4.2-1 of the LRA. This material has the highest copper content (0.216 weight percent) of the vessel beltline materials. However, as listed in RVID, it has only 14 percent of the fluence of the limiting beltline welds covered by the LRA. Appendix G to 10 CFR Part 50, defines the RV beltline or beltline region as the region of the RV (shell material including welds, heat affected zones, and plates or forgings) directly surrounding the effective height of the active core and adjacent regions of the RV that are predicted to experience sufficient neutron radiation damage to be considered in the selection of the most limiting material with regard to radiation damage. The staff concurred with the applicant that this weld is not the limiting material of the RV and that it has sufficiently low fluence. Therefore, this weld would not experience significant neutron radiation damage, and it can be excluded from the list of beltline materials.

The staff determined that the methods used by the applicant for the 60-year USE assessment for the RV beltline materials are consistent with accepted methods and NRC guidance documents. The staff evaluation concluded that the USE values for the ANO-2 beltline materials will remain at or above the 50 ft-lb acceptance criteria of Appendix G to 10 CFR Part 50 through the expiration of the period of extended operation.

The staff confirmed that all RV beltline materials will continue to satisfy the USE value requirements of Appendix G to 10 CFR Part 50 through the end of the period of extended operation for ANO-2. *The staff therefore concludes that the applicant's TLAA for calculating the* USE values of the RV beltline materials is acceptable because it meets the requirements of 10 CFR 54.21(c)(1)(ii) and will ensure that the RV materials will have adequate USE levels and fracture toughness through the end of the period of extended operation.

4.2.2 Pressurized Thermal Shock

Title 10, Section 50.61, of the *Code of Federal Regulations* (10 CFR 50.61) provides the fracture toughness requirements for protecting the RVs of PWRs against the consequences of PTS. The NRC requires licensees to assess the RV materials' projected values for RT_{PTS} through the end of their operating licenses. If approved for license renewal, this would include TLAAs for PTS up through the end of the period of extended operation for ANO-2, assumed to be 48 EFPYs. The rule requires each licensee to calculate the end of license RT_{PTS} value for each material located within the beltline of the reactor pressure vessel. The RT_{PTS} value for each beltline material is the sum of the unirradiated nil-ductility reference temperature (RT_{NDT}) value, a shift in the RT_{NDT} value caused by exposure to high energy neutron irradiation of the material (i.e., ΔRT_{NDT}) value, and an additional margin value to account for uncertainties (i.e., M value). Title 10, Section 50.61, of the *Code of Federal Regulations* (10 CFR 50.61) also provides screening criteria against which the applicant should evaluate the calculated RT_{PTS} values. For RV beltline base metal materials (forging or plate materials) and longitudinal (axial) weld materials, the NRC considers the materials to provide adequate protection against PTS events if the calculated RT_{PTS} values are less than or equal to 132 °C (270 °F). For RV beltline circumferential weld materials, the NRC considers the materials to provide adequate protection against PTS events if the calculated RT_{PTS} values are less than or equal to 149 °C (300 °F). Additionally, 10 CFR 50.61 discusses the calculations of RT_{PTS} values and describes two methods for determining RT_{PTS} for RV materials, depending on if a given RV beltline material is represented in the plant's RV material surveillance program (i.e., Appendix H to 10 CFR Part 50).

4.2.2.1 Summary of Technical Information in the Application

Section 4.2.2 of the LRA addresses the 10 CFR 50.61 requirement for protection of the RV from PTS. The applicant stated that the screening criteria in 10 CFR 50.61 are 132 °C (270 °F) for plates, forgings, and axial welds, and 149 °C (300 °F) for circumferential welds. According to the regulation, if the calculated RT_{PTS} values for the beltline materials are less than the screening criteria, then the RV is acceptable with respect to risk of failure during PTS transients. In this part of the LRA, the applicant described the projected values of RT_{PTS} over the period of extended operation (assumed to be 48 EFPYs in the LRA) to demonstrate that the screening criteria are not violated. The applicant stated that it carried out this analysis and that the results do not exceed the screening criteria. The applicant stated that it projected the calculations through the period of extended operation and met the requirements of 10 CFR 54.21(c)(1)(ii).

Pursuant to 10 CFR 50.61(b)(1), which provides rules for protection against PTS for pressurized-water reactors (PWRs), the NRC requires licensees to assess the projected RT values whenever a significant change occurs in projected values of RT_{PTS}, or upon request for a change in the expiration date for the operation of the facility. For ANO-2 license renewal, RT_{PTS} values are calculated for 48 EFPYs.

The applicant obtained fluence values at 48 EFPYs for ANO-2 at the clad/base metal interface using the methodology described in Reference 4.2-1, as described in Section 4.2.1 above. This method meets the uncertainty requirements of RG 1.190. The applicant estimated a peak inside vessel/clad interface fluence of 5.0896×10^{19} n/cm^2 at 48 EFPYs for the lower shell plates.

Title 10, Section 50.61(b)(2), of the *Code of Federal Regulations* (10 CFR 50.61(b)(2)) establishes screening criteria for RT_{PTS} as 132 °C (270 °F) for plates, forgings, and axial welds, and 149 °C (300 °F) for circumferential welds. Table 4.2-2 of the LRA provides the values for RT_{PTS} at 48 EFPYs for ANO-2. The applicant calculated the projected RT_{PTS} values using RG 1.99, Revision 2, Positions 1 and 2, and they are all within the established screening criteria for 48 EFPYs. The limiting beltline material is the lower shell plate C-8010-1, with a 48-EFPY RT_{PTS} of 50.3 °C (122.6 °F), which is well below the limit of 132 °C (270 °F). Therefore, the applicant has evaluated RT_{PTS} for ANO-2 in accordance with 10 CFR 54.21(c)(1)(ii) and determined it to be acceptable for the period of extended operation.

A comparison of copper content, nickel content, and unirradiated RT_{NDT} values for ANO-2 beltline materials listed in Table 4.2-2 to the values reported in the NRC RVID2 indicates slight differences for selected plate and weld materials. Chemistry factors for surveillance materials have been revised to reflect the use of RG 1.99, Revision 2, Position 2.1. These differences are not significant and do not alter the conclusion that RT_{PTS} values are within the established screening criteria for 48 EFPYs. The upper shell to intermediate shell circumferential weld material is listed in RVID2 but is not included in Table 4.2-2 since it is not a limiting material in accordance with the beltline definition provided in 10 CFR 50.61.

4.2.2.2 Staff Evaluation

The applicant provided its PTS assessment for the period of extended operation for ANO-2 RV beltline materials. The applicant included the assessment for each material in Table 4.2-2 of the LRA. In reviewing the applicant's description of the PTS analysis, the staff evaluated the methods the applicant used to calculate RT_{PTS} values and examined the data and results of the analysis, as summarized in Table 4.2-2 of the LRA.

The staff performed an independent calculation of the RT_{PTS} values for the ANO-2 beltline RV materials, based on the projected 48-EFPY neutron fluence values for the materials. The staff's independent assessment of the most limiting beltline material established that the applicant based the LRA on material information consistent with the RVID data. In reviewing the applicant's description of the PTS analysis, the staff examined the data and results of the analysis, as summarized in Table 4.2-2 of the LRA. The staff's calculated RT_{PTS} values for the RV beltline materials were equivalent to the RT_{PTS} values calculated by the applicant. Both the staff's and the applicant's PTS analyses confirm that the RT_{PTS} values for the ANO-2 beltline materials will remain below the PTS screening criteria of 10 CFR 50.61 through the period of extended operation.

The staff determined that the lower shell plate C-8010-1 is the most limiting material and calculated the 48-EFPY RT_{PTS} value for this material to be 50.3 °C (122.6 °F).

All of the beltline materials are below the 10 CFR 50.61 screening criteria. Based on these considerations, the staff finds the applicant's TLAAs for protecting the ANO-2 vessel against PTS to be acceptable because the staff confirmed that the applicant established the RT_{PTS} values for the RV beltline materials of ANO-2 with methods consistent with NRC guidance documents. The staff therefore concludes that the applicant's TLAA for calculating RT_{PTS} values for the RV beltline materials of ANO-2 is acceptable because it meets the requirements of 10 CFR 54.21(c)(1)(ii) and will ensure that the RV materials will have sufficient protection against PTS events through the end of the period of extended operation.

4.2.3 Pressure-Temperature Limits

The NRC designed the requirements in Appendix G to 10 CFR Part 50 to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. The applicant established the P-T limits by calculations that use the materials and fluence data obtained through the unit-specific Reactor Surveillance Capsule Program. Normally, the P-T limits are calculated for several years into the future and remain valid for an established period of time, not to exceed the expiration date of the current operating license.

The staff evaluates the P-T limit curves based on NRC regulations and guidance. Appendix G to 10 CFR Part 50 requires that P-T limit curves be at least as conservative as those obtained by applying the methodology of Appendix G to Section XI of the ASME Code. Appendix G to 10 CFR Part 50 also provides minimum temperature requirements that an applicant must consider in the development of the P-T limit curves. Section 5.3.2 of the SRP-LR provides an acceptable method for determining the P-T limit curves for ferritic materials in the beltline of the RV based on the linear elastic fracture mechanics methodology of Appendix G to Section XI of the ASME Code. The critical locations in the RV beltline region for calculating heatup and cooldown P-T curves are the 1/4T and 3/4T locations, which correspond to the maximum depth of the postulated inside surface and outside surface defects, respectively.

4.2.3.1 Summary of Technical Information in the Application

In Section 4.2.3 of the LRA, the applicant addressed the requirement in Appendix G to 10 CFR Part 50 that it accomplish normal operations (including heatup, cooldown, and transient operating conditions) and pressure test operations of the RV within established P-T limits. The applicant established these limits by calculations that use the materials and fluence data obtained through the ANO-2 Reactor Surveillance Capsule Program. The applicant based the LRA on an approved license amendment request for reactor coolant system (RCS) P-T limit curves for 32 EFPYs. The curves account for a 7.5-percent power upgrade and were developed using ASME Code Case N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves, Section XI, Division 1," as well as Code Case N-588, "Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels, Section XI, Division 1." In addition, the low-temperature overpressure protection (LTOP) limits are based on the licensed P-T limit analysis. The applicant will also update LTOP limits as required.

Appendix G to 10 CFR Part 50 requires that heatup and cooldown of the reactor pressure vessel be accomplished within established P-T limits. The applicant established these limits by calculations that use materials and fluence data obtained through the unit-specific Reactor Vessel Surveillance Capsule Program. Normally, the P-T limits are calculated for several years into the future and remain valid for an established period of time not to exceed the operating license expiration date.

The applicant submitted a license amendment request for RCS P-T curves for 32 EFPYs (References 4.2-2 and 4.2-3). The curves specify limits on RCS pressure and temperature for up to 32 EFPYs with a 7.5-percent power uprate. The applicant based these P-T curves on a fluence analysis that complies with RG 1.190 and utilizes ASME Code Cases N-640 and N-588. Based on the ANO-2 P-T limit curves, the operating window at 48 EFPYs is sufficient to conduct normal heatup and cooldown operations. The applicant based LTOP limits on the licensed P-T limit analyses and will update them as required.

The applicant has projected calculations of P-T limits for ANO-2 to the end of the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

4.2.3.2 Staff Evaluation

The current P-T limit curves for ANO-2 are acceptable through 32 EFPYs of power operation. In accordance with 10 CFR 50.90, licensees must submit new P-T limit curves for operating reactors to the NRC for review and approval. The licensee may then implement the new approved curves into the technical specifications (TSs) for the reactor units before the expiration of the most current P-T limit curves. The applicant must submit the P-T limit curves for the ANO-2 RV for the period of extended operation for NRC review and approval. The applicant may then implement the P-T limit curves into the TS before the operation of the reactors during the period of extended operation. The staff's review and approval of the extended-period-of-operation P-T limit curves will ensure that the units will be operated in a manner that ensures the integrity of the RCS during the period of extended operation.

4.2.4 FSAR Supplement

Sections A.2.2.1.1, A.2.2.1.2, and A.2.2.1.3 of Appendix A to the LRA provides the applicant's FSAR Supplement for the TLAA on RV neutron embrittlement. The applicant's appropriate consideration of RV neutron embrittlement, including the effects of neutron irradiation on the PTS, USE, and P-T limit assessments, constitutes the basis for the staff's acceptance of the licensee's TLAA evaluation for the period of extended operation.

The applicant did not include a corresponding FSAR Supplement summary description for Table 4.2-2 of the LRA. Table 4.2-2 contains a PTS evaluation for the ANO-2 RV through the expiration of the period of extended operation. The staff notes that the applicant included the corresponding table for the USE extended life evaluation (Table 4.2-1) in the FSAR Supplement. In RAI 4.2-2, the staff requested that the applicant include a corresponding FSAR Supplement summary description for LRA Table 4.2-2 in its FSAR Supplement.

In its response to RAI 4.2-2, the applicant responded that 10 CFR 54.21(d) requires a safety analysis report (SAR) Supplement that contains a summary description of the programs and activities for managing the effects of aging and the evaluation of TLAAs for the period of extended operation. Table 4.2-2 of the LRA provides data for and tabular results of the applicant's evaluation of the RV PTS TLAA for the period of extended operation. Table 4.2-2 is *neither the evaluation of the TLAA, nor a summary description of the evaluation.* Pursuant to 10 CFR 54.21(d), the applicant provided Section A.2.2.1.2 of the LRA as the SAR Supplement summary description of the evaluation of the TLAA for PTS, the results of which are shown in Table 4.2-2 of the LRA.

The ANO-2 SAR does not contain a table equivalent to Table 4.2-2 of the LRA. The applicant identified the limiting beltline material with respect to PTS within the text of SAR Section 5.2.4.3.3, as well as in the proposed SAR Supplement, in Appendix A to the LRA. The ANO-2 SAR does contain a table summarizing the results of the RV USE evaluation. Correspondingly, the proposed SAR Supplement includes an update to this table to account for the period of extended operation. However, no equivalent PTS table is required to maintain the CLB as defined in the ANO-2 SAR for the period of extended operation. The staff finds the response acceptable and considers this issue closed.

On the basis of the staff's review of the FSAR Supplement summary descriptions for the TLAAs on USE, PTS, and P-T limits, as well as the applicant's response to RAI 4.2-2, the staff concludes that the FSAR Supplement summary descriptions in Sections A.2.2.1.2, A.2.2.1.2, and A.2.2.1.3 of the LRA of the evaluations described above are adequate.

4.2.5 Conclusions

The staff has reviewed the TLAAs regarding the maintenance of acceptable Charpy USE levels for the RV materials at ANO-2, as well as the RV's ability to resist failure during postulated PTS events. The staff determined that the applicant's TLAAs for Charpy USE and PTS for ANO-2 meet the respective requirements of Appendix G to 10 CFR Part 50 and 10 CFR 50.61 for RV beltline materials, as evaluated to the end of the period of extended operation. Therefore, on *the basis of this review, the staff concludes that, pursuant to 10 CFR 54.21(c)(1)(ii),* the TLAAs on USE and PTS have been projected to the expiration of the period of extended operation for

ANO-2, and that the applicant will adequately manage the effects of aging on the pressure boundary function for the period of extended operation.

Pursuant to 10 CFR 50.90, the applicant will submit the end of the extended operating term P-T limit curves for ANO-2 before to the expiration of the 32 EFPY P-T limit curves for the plant. The staff's review and approval of the period of extended operation P-T limit curves will ensure that ANO-2 will operate in a manner that ensures the integrity of the reactor coolant pressure boundary for the period of extended operation, and that the end of the extended operating term P-T limit curves will satisfy the requirements of 10 CFR 54.21(c)(1)(ii) and Appendix G to 10 CFR Part 50 for the period of extended operation.

The staff also concludes that the FSAR Supplement contains adequate summary descriptions of the evaluations of the the TLAAs on neutron irradiation embrittlement of RV beltline materials (i.e., the TLAAs on USE, PTS, and P-T limits), as required by 10 CFR 54.21(d).

4.3 Metal Fatigue

A metal component subjected to cyclic loading at loads less than the static design load may fail from fatigue. Metal fatigue of components may have been evaluated based on an assumed number of transients or cycles for the current operating term. The NRC reviews the validity of such metal fatigue analyses for the period of extended operation. NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," identifies fatigue aging-related effects that require evaluation as possible TLAAs pursuant to 10 CFR 54.21(c). The SRP-LR summarizes each of these, and the applicant presented them in Section 4 of the LRA.

The applicant stated that the analyses of metal fatigue at ANO-2 are TLAAs for Class 1 and selected non-Class 1 mechanical components within the scope of license renewal. Fatigue evaluations are TLAAs since they are based on design transients defined for the life of the plant (SAR Section 5.2.1.5). Section III of the ASME Code requires a fatigue analysis for each Class 1 component, considering all transient loads based on the anticipated number of transients. The fatigue analyses require the calculation of cumulative usage factors (CUFs) based on the fatigue properties of the material and the expected fatigue service of the individual component. The ANO-2 Class 1 items that received a code fatigue evaluation in accordance with ASME Code, Section III, Subsection NB, include the pressurizer, the RV, the control element drive mechanism housing assembly, steam generators, RCPs, and the RCS piping.

Non-Class 1 pressure vessels, heat exchangers, storage tanks, and pumps at ANO-2 are designed in accordance with ASME Code, Sections VIII or III, Subsections NC or ND (Classes 2 or 3). Some tanks and pumps are designed to other industry codes and standards, such as American Water Works Association (AWWA) standards and Manufacturer's Standardization Society (MSS) standards. However, only ASME Code, Section VIII, Division 2, and ASME Code, Section III, Subsection NC-3200, include fatigue design requirements.

Fatigue evaluations are TLAAs since they are based on design transients defined for the life of the plant (SAR Section 5.2.1.5). Section 4.3.1.1 of this SER evaluates Class 1 metal fatigue TLAAs, and Section 4.3.1.2 of this SER evaluates non-Class 1 metal fatigue TLAAs.

4.3.1 Summary of Technical Information in the Application

4.3.1.1 Fatigue of ASME Class 1 Components

The applicant stated that it performed fatigue evaluations, contained in calculations and stress reports, in the design of the ANO-2 Class 1 components in accordance with the requirements specified in ASME Section III for Class 1 components. Because the applicant based these fatigue evaluations on a number of cycles assumed for a 40-year plant life, these evaluations are TLAAs.

The ability to withstand cyclic operation without fatigue failure is expressed in terms of the required calculation of CUFs for ASME Code, Section III, Class 1 components. The applicant compiled the ANO-2 CUFs for the Class 1 components designed in accordance with ASME Code, Section III, considering the RCS design transients used to develop the CUFs for the RV, the control element drive mechanism housing assembly, the pressurizer, steam generators, RCPs, and RCS piping. The applicant stated that it reviewed the number of RCS design transients accrued through 2002 for ANO-2 and linearly extrapolated them to 60 years of operation, as reported in Table 4.3-1 of the LRA. In all instances, the applicant found the number of RCS design transients assumed in the original design to be acceptable for 60 years of operation, and the CUFs will therefore remain within the ASME Code, Section III, Class 1 fatigue limit. On this basis, the applicant concluded that the metal fatigue TLAAs will remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i). The applicant also stated that it monitors RCS design transients through the Fatigue Monitoring Program, which Appendix B discusses.

4.3.1.2 Fatigue of ASME Non-Class 1 Components

The applicant stated that each mechanical system it reviewed as part of the integrated plant assessment and reported in Sections 3.2 through 3.4 of the LRA was also screened to identify potential metal fatigue TLAAs. The applicant accomplished this using a screening process to identify non-Class 1 components that may have normal/upset condition operating temperatures in excess of 104 °C (220 °F) for carbon steel or 132 °C (270 °F) for austenitic stainless steel. The following subsections present the results of the TLAA fatigue review for non-Class 1 mechanical systems within the scope of license renewal.

4.3.1.2.1 Piping and In-Line Components

Mechanical systems containing piping components that exceed the screening criteria listed above include primary sampling, low-pressure safety injection/shutdown cooling, containment spray, chemical and volume control system (CVCS), emergency diesel generator, alternate alternating current diesel generator, containment penetrations, main feedwater, main steam, emergency feedwater, and blowdown/steam generator secondary. The piping components that exceed the screening criteria were designed to American National Standards Institute (ANSI) B31.1, which does not require an explicit fatigue analysis but specifies allowable stress levels based on the number of anticipated thermal cycles. Specifically, a stress reduction is not required in the design of piping that is not expected to experience more than 7000 cycles. These piping components were evaluated for their potential to exceed 7000 thermal cycles in 60 years of plant operation. Only the RCS hot-leg sampling piping potentially exceeds 7000 cycles during the period of extended operation. Therefore, the applicant revised a pertinent calculation to justify RCS sampling to occur at any reasonable frequency for 60 years of operation without exceeding the allowable number of cycles. On this basis, the applicant concluded that the fatigue analyses for all non-Class 1 components at ANO-2 remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.3.1.2.2 Pressure Vessels, Heat Exchangers, Storage Tanks, and Pumps

Only non-Class 1 pressure vessels, heat exchangers, storage tanks, and pumps designed and fabricated in accordance with ASME Code, Section VIII, Division 2 or ASME Code, Section III, NC-3200 require evaluation for thermal fatigue. The NRC does not require fatigue evaluation for other design codes (e.g., ASME Code, Section VIII, Division 1; AWWA; or MSS), and components designed and fabricated with these codes are suitable for the period of extended operation without further evaluation. The applicant's engineering evaluations identified no non-Class 1 pressure vessels, heat exchangers, storage tanks, or pumps requiring evaluation for thermal fatigue.

4.3.1.3 *Response to Industry Experience*

The nuclear industry reviews events that occur at nuclear power plants and new findings discovered by research. Industry experience and new research have found fatigue issues such as thermal stratification and environmentally assisted fatigue that were not considered in the original plant designs. Some of these findings impact the fatigue analysis and result in the issuance of NRC generic communications. The following sections discuss the concerns that are directly related to metal fatigue.

4.3.1.3.1 Generic Safety Issue 190, "Environmentally Assisted Fatigue"

Recent test data indicate that certain environmental effects (e.g., temperature, oxygen, and strain rate) in the primary systems of LWRs could result in greater susceptibility to fatigue than fatigue analyses would predict based on the ASME Code, Section III, design fatigue curves. The ASME design fatigue curves were based on laboratory tests in air at low temperatures. Although the failure curves derived from laboratory tests were adjusted to account for effects such as data scatter, size effect, and surface finish, the NRC is concerned that these adjustments may not be sufficient to account for actual plant operating environments.

The NRC implemented a fatigue action plan to systematically assess fatigue issues in operating plants. As reported in SECY-95-245, which documented the results of the fatigue action plan, the NRC believes that no immediate staff or licensee action is necessary to deal with the fatigue issues addressed by the fatigue action plan. In addition, the staff concluded that it could not justify requiring a backfit of the environmental fatigue data to operating plants. However, the NRC concluded that because metal fatigue effects increase with service life, the action plan fatigue issues should be evaluated for any proposed period of extended operation for license renewal. Specifically, as part of the resolution of Generic Safety Issue (GSI)-166, which resulted in the initiation of GSI-190, "Environmentally Assisted Fatigue," the NRC will consider the need to evaluate a sample of components of high-fatigue usage applying the latest available environmental fatigue data. The NRC intends to ensure that components will continue to perform their intended functions during the period of extended operation associated with license renewal.

As a part of the effort to close GSI-166 for operating nuclear power plants during the current 40-year license term, Idaho National Engineering Laboratory evaluated fatigue-sensitive component locations at plants designed by the four U.S. nuclear steam supply system vendors. NUREG/CR-6260 provides the results of those evaluations. Section 5.2 of NUREG/CR-6260 identifies the following component locations to be most sensitive to environmental effects for older Combustion Engineering (CE) plants (these locations and the subsequent calculations are directly relevant to ANO-2):

- reactor vessel shell and lower head
- reactor vessel inlet and outlet nozzles
- surge line
- charging nozzle
- safety injection nozzle
- shutdown cooling system Class 1 piping

Table 5-43 of NUREG/CR-6260 summarizes the evaluation of the six limiting locations for the current term of operation (40 years) and the period of extended operation (60 years in total). Of the six limiting locations NUREG/CR-6260 evaluates, the pressurizer surge line is the only one for which the CUF exceeded 1.0 when extrapolated to 60 years. However, the evaluations contained in NUREG/CR-6260 use the interim fatigue curves published in NUREG/CR-5999, which have been superseded by the fatigue curves reported in NUREG/CR-6717. Therefore, the applicant must reevaluate the assessment of environmental effects for the limiting six locations for ANO-2 using the fatigue life correction factors reported in NUREG/CR-6717, Section 5.3. The limiting locations listed above should be evaluated for environmental effects in accordance with the guidance provided in the GALL Report using the fatigue life correction factors reported in NUREG/CR-6717, Section 5.3. The limiting vessel locations are made of low-alloy steel, the safety injection and charging nozzles are made of carbon steel, and the shutdown cooling system piping and pressurizer surge line piping are stainless steel. Using NUREG/CR-6717, the bounding fatigue life correction factor for low-alloy steel, carbon steel, and stainless steel are 2.5, 1.74, and 15.4, respectively.

The following summarizes the revised usage factors when including these environmental correction factors:

- reactor vessel head-to-shell juncture (low-alloy steel) 0.0075
- reactor vessel outlet nozzle (low-alloy steel) 0.2223
- reactor vessel inlet nozzle (low-alloy steel) 0.347
- pressurizer surge line (stainless steel) 15.24
- charging nozzle (carbon steel) 1.357
- safety injection nozzle (carbon steel) 0.6534
- shutdown cooling line (stainless steel) 9.930

For the charging nozzle, shutdown cooling line piping, and pressurizer surge line piping, the applicant would have to use more detailed stress analyses or fatigue monitoring and cycle counting to reduce the CUF below 1.0. Because of the factor of safety included in the ASME Code, a CUF greater than 1.0 does not indicate that fatigue cracking is expected. However, there is a potential for fatigue cracking during the period of extended operation at locations having CUFs exceeding 1.0. Therefore, before entering the period of extended operation, the applicant will develop an approach for each location that may exceed a CUF of 1.0 when considering environmental effects, in order to show that it can manage the effects of fatigue. The approach for addressing environmental fatigue for the above locations will include one or more of the following options:

- Further refine the fatigue analysis to lower the CUFs to below 1.0.

- Repair the affected locations.

- Replace the affected locations.

- Manage the effects of fatigue at the designated locations by an inspection program that the NRC staff has reviewed and approved (e.g., periodic nondestructive examination of the affected locations at inspection intervals to be determined by a method acceptable to the NRC staff). The NRC staff expects that the inspections will be able to detect cracking from thermal fatigue before the loss of function. The applicant will then implement replacement or repair such that it will maintain the intended function for the period of extended operation.

- Monitor ASME Code activities to use the environmental fatigue methodology approved by the Code committee and the NRC.

Should ANO-2 select option 4 (inspection) to manage environmentally assisted fatigue during the period of extended operation, the applicant will provide details such as scope, qualification, method, and frequency to the NRC staff for review and approval before entering the period of extended operation. To obtain NRC staff approval of its proposed inspection plan to manage fatigue prior to entering the period of extended operation for ANO-2, the applicant will submit a license amendment request. After the NRC staff's approval of the inspection plan, any future changes to the inspection plan will be evaluated in accordance with 10 CFR 50.59.

The applicant has evaluated the effects of environmentally assisted thermal fatigue for the limiting locations identified in NUREG/CR-6260 for ANO-2 in accordance with 10 CFR 54.21(c)(1)(i and ii), and the NRC finds all locations acceptable for the period of extended operation, with the exception of the charging nozzle, shutdown cooling line, and pressurizer surge line. The applicant will address cracking of these locations by environmentally assisted fatigue using one of the five approaches discussed above in accordance with 10 CFR 54.21(c)(1).

4.3.1.3.2 NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems"

In Section 4.3.3.2 of the LRA, the applicant addressed a concern identified in NRC Bulletin 88-08 regarding potential temperature stratification or temperature oscillations in unisolable sections of piping attached to the RCS. Previously, Entergy had provided the NRC with the responses required by Bulletin 88-08 and its supplements.

Based on the Entergy responses, the NRC staff found that ANO-2 meets the requirements of NRC Bulletin 88-08. Commitments regarding inspections at ANO-2 in response to NRC Bulletin 88-08 have been superseded by the risk-informed inservice inspection (RI-ISI) of Class 1 piping, as approved by the NRC. Although the staff does not expect aging effects from thermal stratification as described in Bulletin 88-08, the applicant will confirm the absence of cracking from thermal fatigue by inspections as part of the Inservice Inspection Program, in accordance with 10 CFR 54.21(c)(1)(iii), during the period of extended operation.

4.3.1.3.3 NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification"

In Section 4.3.3.3 of the LRA, the applicant addressed pressurizer surge line thermal stratification as an issue identified in NRC Bulletin 88-11. The bulletin requires the applicant to analyze the effects of this mechanism on the stress and fatigue calculations for the surge line. Combustion Engineering (CE) performed a generic and bounding analysis for all CE plants and submitted it to the NRC. To address this issue for the purposes of license renewal, the applicant will include the pressurizer surge line bounding locations in the Fatigue Monitoring Program. Therefore, the applicant will track realistic fatigue usage for the surge line and will take actions to reevaluate, repair, or replace the surge line before a fatigue-induced failure occurs. The applicant will manage the effects of aging in accordance with 10 CFR 54.21(c)(1)(iii) for the period of extended operation.

4.3.2 Staff Evaluation

4.3.2.1 Fatigue of ASME Class 1 Components

The staff has reviewed Section 4.3.1 of the LRA, in which the applicant addressed fatigue evaluations of Class 1 components.

In RAI 4.3.1-1, the staff requested that the applicant list the editions of the ASME Code, Section III, that apply to Class 1 fatigue analysis. The applicant provided these editions in its response to the RAI, and the staff found them acceptable because they conform to the codes listed in Table 3.2.4 of the ANO-2 SAR and to industry practice. In RAIs 4.3.1-2 and 4.3.1-3, the staff asked the applicant to indicate if it logged the number of transient cycles listed up to July 11, 2002, in Table 4.3.1 of the LRA since the start of operation, and if the applicant logged additional cycles since compiling the table. In its response, the applicant verified that it had logged the cycles since the start of operation, and that it had recorded two reactor trips, one cooldown cycle, and one heatup cycle, since July 11, 2002. This supported the applicant's statement that the number of projected design cycles through the period of extended operation will be well below the number of assumed design transient cycles. The staff finds the response reasonable and in conformance with general experience at operating nuclear plants, and it concurs with the applicant that the actual number of transient cycles under operating conditions will be smaller that the number of assumed design cycles through the period of extended operation.

On the basis of its review, the staff concludes that the applicant has provided an adequate demonstration, pursuant to 10 CFR 54.21(c)(1)(i), that the ANO-2 fatigue TLAAs for Class 1 components will remain valid for the period of extended operation.

Section A.2.2.2.1 of the LRA provides the applicant's supplement for the ANO-2 FSAR regarding Class 1 metal fatigue. The staff reviewed this supplement and finds it provides an adequate summary of the evaluation of Class 1 metal fatigue.

4.3.2.1.1 Conclusion

On the basis of its review, the staff concludes that the applicant has adequately demonstrated, pursuant to 10 CFR 54.21(c)(1), regarding fatigue TLAAs for ASME Class 1, that (1) some of the analyses remain valid for the period of extended operation, (2) some of the analyses have been projected to the end of the period of extended operation, or (3) it will adequately manage the effects of aging on the intended function(s) for the period of extended operation.

The staff also concludes that the FSAR Supplement contains an adequate summary description of ASME Code, Class 1 metal fatigue TLAAs evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.3.2.2 Fatigue of ASME Non-Class 1 Components

The staff has reviewed Section 4.3.2 of the LRA, in which the applicant addressed fatigue evaluations of ASME non-Class 1 components.

In RAI 4.3.2-1, the staff requested that the applicant provide the design codes that it used for non-Class 1 fatigue analysis. In its reply, the applicant stated that non-Class 1 piping was designed to ANSI B31.1 or ASME Code, Section III, Classes 2 and 3. Non-Class 1 pressure vessels, heat exchangers, storage tanks, and pumps were designed in accordance with ASME Code, Section VIII, Division 1 or ASME Code, Section III, Classes 2 and 3. These codes conform with those listed in Table 3.2-4 of the ANO-2 SAR and with industry practice, and are therefore acceptable.

In RAI 4.3.2-2, the staff requested that the applicant provide the basis for the temperature screening criteria of 104 °C (220 °F) for carbon steel and 132 °C (270 °F) for stainless steel. In its response, the applicant stated that it based these criteria on industry-sponsored investigations and evaluations of thermal fatigue in operating nuclear power plant piping, systems, and components. The applicant also stated that these screening criteria are consistent with the screening criteria given in Section 4.3.2 of the St. Lucie LRA. The staff finds that the applicant's screening criteria conform with industry practice and are therefore acceptable.

4.3.2.2.1 Piping and In-Line Components

In RAI 4.3.2-3, the staff asked the applicant to clarify the revision of the RCS hot-leg sampling piping calculation to justify RCS sampling at any reasonable frequency for 60 years of operation, without exceeding the allowable number of cycles. In its response, the applicant provided the requested justification. The staff has evaluated the response and finds it reasonable and acceptable, because it conforms with industry practice.

4.3.2.2.2 Pressure Vessels, Heat Exchangers, Storage Tanks, and Pumps

The applicant stated that it did not identified any non-Class 1 pressure vessels, heat exchangers, storage tanks, or pumps that required evaluation for thermal fatigue. The staff finds this acceptable because it conforms to similar findings in previously accepted LRAs.

In RAI 3.3-1, the staff indicated that Tables 3.3.2-5 and 3.3.2-11 of the LRA identify fatigue-cracking as an aging effect requiring management, but that Section 4.3.2 of the LRA does not reflect this condition. The applicant credited inspections associated with the Periodic Surveillance and Preventive Maintenance Program and system walkdowns with managing this aging effect in the CVCS pump casing. The staff requested that the applicant clarify the type of fatigue managed by these inspections, the basis for inspections in lieu of a TLAA for this component, and the effectiveness of these inspections in detecting internal cracks before the loss of intended function. In its response, the applicant stated that, regarding the CVCS charging pump casing, it identified and managed cracking from high-cycle fatigue (as a result of the deflection of the charging pump plunger cap during a pump cycle) as the aging effect. The applicant discovered this cracking during plant operation and documented it in the Corrective Action Program. The applicant stated that there is no requirement for an analysis involving time-limited assumptions, and it found no such analysis for this condition during its identification of TLAAs for license renewal. It is therefore outside the scope of Section 4.3.2 of the LRA. However, the components listed in Table 3.3.2-11 of the LRA are generally nonsafety-related but are designed in accordance with ANSI B31.1, which has an implicit limit of 7000 thermal cycles. Cracking from thermal fatigue is generally not expected to occur, but the applicant conservatively identified it as an aging effect requiring management. The applicant also stated that, for the charging plunger cap, a preventive maintenance task exists to disassemble and inspect the charging pumps and plungers. Operating experience has shown this inspection to be effective in identifying the effects of aging before the loss of system function. For other components, system walkdowns detect leakage and spray from liquid-filled systems.

On the basis of its review, the staff finds that the applicant has provided an adequate demonstration, pursuant to 10 CFR 54.21(c)(1), that the ANO-2 metal fatigue for ASME non-Class 1 components will remain valid for the period of extended operation, because it conforms with industry operating practice.

Section A.2.2.2.2 of the LRA provides the applicant's supplement for the ANO-2 FSAR regarding fatigue TLAAs of ASME non-Class 1 components. The staff has reviewed this supplement and finds it provides an adequate summary of the evaluation of metal fatigue of ASME non-Class 1 components at ANO-2 , as required by 10 CFR 54.21(d).

4.3.2.2.3 Conclusion

On the basis of its review, the staff concludes that the applicant has adequately demonstrated, pursuant to 10 CFR 54.21(c)(1), regarding fatigue TLAAs for ASME Class 1 and non-Class 1 components, that (1) some of the analyses remain valid for the period of extended operation, (2) some of the analyses have been projected to the end of the period of extended operation, or (3) it will adequately manage the effects of aging on the intended function(s) for the period of extended operation.

The staff also concludes that the FSAR Supplement contains an adequate summary description of ASME Class 1 and non-Class 1 metal fatigue TLAAs evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.3.2.3 Response to Industry Experience

4.3.2.3.1 Effects of Reactor Coolant Environment on Fatigue Life of Components and Piping (Generic Issue 190)

Generic Safety Issue (GSI)-166, "Adequacy of the Fatigue Life of Metal Components," raised concerns regarding the conservatism of the fatigue curves used in the design of the RCS components. Although GSI-166 was resolved for the current 40-year design life of operating components, the staff identified GSI-190, "Fatigue Evaluation of Metal Components for 60-year Plant Life," to address license renewal. The NRC closed GSI-190 in December, 1999, concluding that: "*The results of the probabilistic analyses, along with the sensitivity studies performed, the iterations with industry (NEI and EPRI), and the different approaches available to the licensees to manage the effects of aging, lead to the conclusion that no generic regulatory action is required, and that GSI-190 is closed. This conclusion is based primarily on the negligible calculated increases in core damage frequency in going from 40 to 60 year lives. However, the calculations supporting resolution of this issue, which included consideration of environmental effects, and the nature of age-related degradation indicate the potential for an increase in the frequency of pipe breaks as plants continue to operate. Thus, the staff concludes that, consistent with existing requirements in 10 CFR 54.21, licensees should address the effects of coolant environment on component fatigue life as aging management programs are formulated in support of license renewal.*"

In accordance with the staff position stated above, the applicant has evaluated the component locations listed in NUREG/CR-6260 that are applicable to older Combustion Engineering plants for the effect of the environment on the fatigue life of the corresponding components. For each location, detailed environmental fatigue calculations were performed using the appropriate correction factors reported in Section 5.3 of NUREG/CR 6717, *"Environmental Effects on Fatigue Crack Initiation in Piping and Pressure Vessel Steels,"* May 2001.

The limiting locations in NUREG-6260 were found to be acceptable for extended operation, except for the charging nozzle, the shut down cooling line, and the pressurizer surge line. The applicant has committed to manage the environmental fatigue effects at these locations during the period of extended operations in accordance with the five options listed in Section 4.3.3.1 of the LRA. The staff has reviewed these options and finds them acceptable because the options conform with the staff position on management of environmentally-assisted fatigue and were previously found acceptable in other license applications.

Based on its review, the staff finds that the effects of environmental-assisted thermal fatigue for the limiting locations identified in NUREG-6260 have been adequately evaluated for ANO-2, in accordance with 10 CFR 54.21(c)(1)(i) and 10 CFR 54.21(c)(1)(ii), and that, with the exception of the charging nozzle, shutdown cooling line, and pressurizer surge line, the remaining locations are acceptable for the period of extended operation.

In accordance with 10 CFR 54.21(c)(1), the staff also finds acceptable the applicant's commitment to address potential cracking by environmentally-assisted fatigue at these locations through the application of one of the five options discussed in Section 4.3.3.1 of the LRA, because they have been found acceptable for other license renewal applications. Should ANO-2 select the inspection option (Option 4) to manage environmentally-assisted fatigue, details of the scope, qualification, method, and frequency of the inspection will be provide to the NRC for review and approval prior to entering the period of extended operation.

In accordance with 10 CFR 54.21(d), the applicant has included a section addressing the effects of reactor coolant environment on fatigue life of components and piping (GSI-190) in the ANO-2 FSAR Supplement Section A.2.2.2.3. The staff finds this supplement provides a adequate summary description of the information presented, and the commitments made, in Section 4.3.3.1 of the LRA.

4.3.2.3.2 NRC Bulletin 88-08, Thermal Stresses in Piping Connected to Reactor Coolant Systems

The staff has reviewed Section 4.3.3.3 of the LRA, where the applicant addressed thermal stresses in piping connected to reactor coolant systems as an issue identified in NRC Bulletin 88-08. The applicant stated that the Entergy commitments regarding inspections at ANO-2, in response to NRC Bulletin 88-08, have been superseded by the risk-informed inspection (RI-ISI) of ASME Class 1 piping, as approved by the NRC. Although aging effects due to thermal stratification as described in Bulletin 88-08 are not expected, the absence of cracking due to thermal fatigue will be confirmed by inspections as part of the inservice inspection program through the period of extended operation.

The staff finds the applicant's statements adequate because it conforms with the staff position on thermal stratification, which forms part of the risk-informed inspection requirements of ASME

Class 1 piping, and because the effects of aging associated with thermal stresses in piping connected to reactor coolant systems will be managed, in accordance with 10 CFR 54.21 (c) (1) (iii), for the period of extended operation.

The applicant's supplement to the ANO-2 FSAR regarding thermal stresses in piping connected to reactor coolant systems is provided in Section A.2.2.2.4 of the LRA. The staff has reviewed this supplement and finds it provides an adequate summary description of the metal fatigue TLAA, as required by 10 CFR 54.21(d).

4.3.2.3.3 NRC Bulletin 88-11, Pressurizer Surge Line Thermal Stratification

The staff has reviewed Section 4.3.3.3 of the LRA, where the applicant addressed pressurizer surge line thermal stratification as an issue identified in NRC Bulletin 88-11. The applicant has addressed this issue for the purposes of license renewal, by committing to include the pressurizer surge line bounding locations in the fatigue monitoring program. The applicant stated that realistic fatigue usage for the surge line will be tracked, and actions will be taken to reevaluate, repair, or replace the surge line before a fatigue-induced failure occurs. The staff finds this acceptable because the effects of aging associated with pressurizer surge line thermal stratification will be managed in accordance with 10 CFR 54.21(c)(1)(iii) for the period of extended operation.

The applicant's supplement to the ANO-2 FSAR regarding pressurizer surge line stratification is provided in Section A.2.2.2.5 of the LRA. The staff has reviewed this supplement and finds it provides an adequate summary description of the metal fatigue TLAA, as required by 10 CFR 54.21(d).

4.3.2.3.4 Conclusion

On the basis of its review, the staff concludes that the applicant has adequately demonstrated, pursuant to 10 CFR 54.21(c)(1), that the TLAAs associated with specific industry experience are acceptable in that the fatigue analyses for affected components: (i) remain valid for the period of extended operation, or (ii) have been projected to the end of the period of extended operation, or (iii) ensure that the effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

The staff also concludes that the FSAR Supplement contains an adequate summary description of the responses to industry experience, as required by 10 CFR 54.21(d).

4.3.3 Conclusion

On the basis of its review, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1), that metal fatigue TLAAs are adequate in that the fatigue analyses: (i) remain valid for the period of extended operation, or (ii) have been projected to the end of the period of extended operation, or (iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

The staff also concludes that Section A.2.2.2 of the FSAR Supplement contains an adequate summary description of the metal fatigue TLAA evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.4 Environmental Qualification of Electrical Equipment

The NRC has identified the 10 CFR 50.49 Environmental Qualification Program as a TLAA for the purposes of license renewal. The TLAA of environmental qualification (EQ) for electrical components includes all long-lived, passive, and active electrical and instrumentation and control components that are located in a harsh environment. The harsh environments are those areas of the plant that are subjected to environmental effects by a loss-of-coolant accident or high-energy line break (HELB) and that are important to safety. This equipment consists of safety-related and Q-list equipment, nonsafety-related equipment whose failure could prevent satisfactory accomplishment of any safety-related function, and the necessary postaccident monitoring equipment.

Pursuant to 10 CFR 54.21(c)(1), an applicant must provide a list of EQ TLAAs in the LRA. The applicant must demonstrate that one of the following is true for each piece of EQ equipment:

- The analyses remain valid for the period of extended operation.
- The analyses have been projected to the end of the period of extended operation.
- The effect of aging on the intended function(s) will be adequately managed for the period of extended operation.

The aging (or qualified life) analysis for electrical components involving time-limited assumptions as defined by the current operating term for ANO-2 (i.e., 40 years), included as part of the 10 CFR 50.49 Environmental Qualification Program, meets the 10 CFR 54.3 definition for a TLAA. The NRC thus considers the Environmental Qualification Program's aging evaluation for electrical components a TLAA for license renewal.

As described in Section X.E1 of the GALL Report, the staff concludes that a plant's EQ program, which implements the requirements of 10 CFR 50.49 (as further defined and clarified by the DOR Guidelines, NUREG-0588, and RG 1.89, Revision 1), meets the 10 program attributes (or elements) for an acceptable AMP as described in the GALL Report. A plant's EQ program is therefore viewed as an acceptable AMP for license renewal.

An applicant performs a reanalysis of an aging evaluation in order to extend the qualification of electrical components under 10 CFR 50.49(e) on a routine basis as part of a plant's EQ program. Important attributes for the reanalysis of an aging evaluation include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met). Section X.E1 of the GALL Report further discusses these attributes.

The applicant may apply this reanalysis program to EQ components now qualified for the current operating term (i.e., those components now qualified for 40 years or more). The staff has concluded, as described in the Section X.E1 of the GALL Report, that a reanalysis program, which meets the conditions defined in the GALL Report for important attributes, is an acceptable AMP for license renewal. Thus, the NRC recommends no further evaluation for license renewal if an applicant elects this option under 10 CFR 54.21(c)(1)(iii).

The staff reviewed Sections 4.4 and B.1.8 of the LRA to determine whether the applicant has demonstrated that it will adequately manage the effects of aging on the intended function(s) of electrical components through the ANO-2 EQ Program, together with other plant programs/processes, during the period of extended operation as required by 10 CFR 54.21(c)(1)(iii).

4.4.1 Summary of Technical Information in the Application

Sections 4.4 and B.1.8 of the LRA discuss the applicant's TLAA for electrical components. The applicant stated that the ANO-2 Environmental Qualification Program is an existing program established to meet ANO-2 commitments for 10 CFR 50.49. The Environmental Qualification Program is consistent with Section X.E1 of the GALL Report.

The applicant concluded that continued implementation of the ANO-2 Environmental Qualification Program provides reasonable assurance that the aging effects will be managed, and that electrical components, within the scope of 10 CFR 50.49 requirements, will continue to perform their intended function(s) for the period of extended operation. The ANO-2 Environmental Qualification Program will manage the effects of aging in accordance with the requirements of 10 CFR 54.21(c)(1)(iii).

Sections A.2.1.8 and A.2.2.3 of the LRA discuss the applicant's proposed FSAR Supplement for the ANO-2 EQ Program. The applicant stated that the Environmental Qualification Program manages component thermal, radiation, and cyclical aging of electrical equipment important to safety as required by 10 CFR 50.49. The Environmental Qualification Program manages aging effects through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. Aging evaluations for EQ components that specify a qualification of at least 40 years are considered TLAAs for license renewal. The Environmental Qualification Program ensures that the applicant will maintain the qualification of these EQ components. The applicant will thus manage the effects of aging in accordance with 10 CFR 54.21(c)(1)(iii).

The ANO-2 Environmental Qualification Program manages component thermal, radiation, and cyclical aging, as applicable, through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. As required by 10 CFR 50.49, the applicant must refurbish, replace, or have the qualification of EQ components not qualified for the current license term extended before reaching the aging limits established in the evaluation. The NRC considers aging evaluations for EQ components that specify a qualification of at least 40 years to be a TLAA for license renewal. The Environmental Qualification Program ensures the maintenance of these EQ components in accordance with their qualification bases.

The ANO-2 Environmental Qualification Program is an existing program established to meet ANO-2 commitments for 10 CFR 50.49. It is consistent with Section X.E1 of the GALL Report. The ANO-2 program includes consideration of operating experience to modify qualification bases and conclusions, including qualified life. Compliance with 10 CFR 50.49 provides reasonable assurance that components can perform their intended function(s) during accident conditions after experiencing the effects of inservice aging. Consistent with NRC guidance provided in RIS 2003-09, the NRC requires no additional information to address GSI-168, "EQ of Electrical Components."

Based upon a review of the existing program and associated operating experience, continued implementation of the ANO-2 Environmental Qualification Program provides reasonable assurance that the applicant will manage the aging effects and that the in-scope EQ components will continue to perform their intended function(s) for the period of extended operation. The ANO-2 Environmental Qualification Program will manage the effects of aging will be managed in accordance with the requirements of 10 CFR 54.21(c)(1)(iii).

4.4.2 Staff Evaluation

The staff reviewed the information in Sections 4.4 and B.1.8 of the LRA to determine whether the applicant has demonstrated that the effects of aging on the intended function(s) of electrical components will be adequately managed through the ANO-2 Environmental Qualification Program, together with other plant programs/processes, during the period of extended operation as required by 10 CFR 54.21(c)(1)(iii). Based on the applicant's statement that the Environmental Qualification Program is consistent with Section X.E1 of the GALL Report, the staff concludes that the ANO-2 Environmental Qualification Program will adequately manage the effects of aging on the intended function(s) of electrical components for the period of extended operation in accordance with 10 CFR 54.21(c)(1)(iii).

Sections A.2.1.8 and A.2.2.3 of Appendix A to the LRA contain the applicant's FSAR Supplement for the Environmental Qualification Program as an AMP and TLAA for license renewal. The staff reviewed this section and finds that the program description is consistent with the material contained in Sections 4.4 and B.1.8 of the LRA. The staff finds that the FSAR Supplement provides an adequate summary of the program activities as required by 10 CFR 54.21(d).

4.4.3 Conclusions

The staff has reviewed the information in Sections 4.4 and B.1.8 of the LRA. On the basis of this review, the staff concludes that the applicant has demonstrated that it will adequately manage the effects of aging on the intended function(s) of electrical components that meet the definition for TLAA as defined in 10 CFR 54.3 during the period of extended operation, as required by 10 CFR 54.21(c)(1)(iii). In addition, the staff concluded, that the FSAR Supplement contains an adequate summary description of the programs and activities for the evaluation of TLAAs for the period of extended operation, as required by 10 CFR 54.21(d).

4.5 Concrete Containment Tendon Prestress

4.5.1 Summary of Technical Information in the Application

The applicant stated the mechanism it considered in developing the TLAA as follows:

> Loss of prestress in the containment post-tensioning system is due to material strain occurring under constant stress. The analysis of loss of prestress over the initial 40-year license term is discussed in SAR Section 3.8.1.3.4, and is a time-limited aging analysis requiring review for license renewal. By assuming an appropriate initial stress from tensile loading and using appropriate pre-stress loss parameters, the magnitude of the design losses and the final effective prestress at the end of 40 years for typical dome, vertical, and hoop tendons was calculated at the time of initial licensing and following steam generator replacement activities. A structural proof test was performed to verify the adequacy of the containment building design.

Furthermore, the applicant stated that it will manage the loss of tendon prestress in the containment building posttensioning system for license renewal through containment ISIs. The containment ISI includes tendon surveillance testing. The ANO-2 tendon surveillance procedures incorporate the requirements of ASME Code, Section XI, Subsection IWL and 10 CFR 50.55(a).

Moreover, the applicant asserted the following:

> Calculation of the effective prestress of the containment post-tensioning system at 60 years has been performed and shows the containment tendons will be acceptable for the period of extended operation. In addition, the Containment Inservice Inspections will be adequate to manage the effects of aging on the containment post-tensioning system for the period of extended operation. Therefore, the applicant considers this TLAA acceptable in accordance with 10 CFR 54.21(c)(1)(ii) and (c)(1)(iii).

4.5.2 Staff Evaluation

The applicant provided a description of the TLAA without providing any quantitative comparison as to the present level of the prestressing forces based on the measured prestressing forces, trend lines and projected forces during the extended period of operation. In order to understand the basis for its assertions in Section 4.5.1 of this SER, the staff requested the following information.

<u>RAI 4.5-1</u>

For the discussion of prestressing force losses over the initial 40 years, Section 4.5.1 of the LRA refers to SAR Section 3.8.1.3.4 through a hypertext link. A review of SAR Section 3.8.1.3.4 indicates that it discusses the approach used in designing the containment to satisfy the load combinations in SAR Section 3.8.1.3.3. It does not discuss the estimation of prestressing forces at 40 years. The NRC requested the applicant to provide a reference to any other SAR Section which discusses the estimation of prestress force losses.

RAI 4.5-2

The use of 10 CFR 54.21(c)(1)(ii–iii) is appropriate for the concrete containment tendon prestress TLAA. However, the staff must assess the plant-specific operating experience regarding the residual prestressing forces in the containment. Based on the analysis performed pursuant to 10 CFR 54.21(c)(1)(ii), the NRC requested the applicant to provide the following information:

(a) minimum required prestressing forces for each group of tendons

(b) trend lines of the projected prestressing forces for each group of tendons based on the regression analysis of the measured prestressing forces (see NRC Information Notice (IN) 99-10 for more information)

(c) plots showing comparisons of prestressing forces projected to 40 years and 60 years with the minimum required prestress for each group of tendons

RAI 4.5-3

In Section A.2.2.4 of the FSAR Supplement of the LRA, the applicant summarized the results of its TLAA and stated the following:

> Calculation of the acceptability of the effective prestress of the containment building post-tensioning system at 60 years has been performed to show that the containment building tendon elements will be acceptable for the period of extended operation in accordance with 10 CFR 54.21(c)(1)(ii).

By letter dated June 16, 2004, the applicant provided responses to these RAIs, discussed below.

In response to RAI 4.5-1, the applicant provided the following values:

- loss from shrinkage and creep of concrete—420μ
- loss from relaxation of prestressing steel—14.28 ksi for each group of tendons

The shrinkage and creep values (considering the sustained compressive stress of 1500 psi) is in the lower bound of the values suggested in RG 1.35.1. The steel relaxation value of 14.25 kilograms per square inch (ksi) (translates as 8 percent of the initial stress in the wires of the tendons) is in the middle range of medium-relaxation prestressing steel. As a large deviation from these values in the containment will show up in the non-normalized measured prestressing forces, it is essential to have an accurate evaluation of the measured tendon forces for a credible TLAA. For the purpose of estimating the minimum required prestressing forces in each group of tendons, the staff considers these values reasonable.

In response to RAI 4.5-2(a), the applicant provided the following minimum required prestressing forces:

- hoop tendons—1205.28 kips/tendon
- dome tendons—1233.18 kips/tendon
- vertical tendons—1370.82 kips/tendon

The staff finds these to be reasonable values for this type of containment.

In response to RAI 4.5-2 (b) and (c) dated June 16, 2004, the applicant explained that it had started its random sampling program for ANO-2 containment in 1999. However, the applicant provided the normalized prestressing force values of randomly selected tendons for each group of tendons for ANO-1. A review of this data indicated that the process used for constructing trend lines is not acceptable. In figures 1, 2, and 3, the applicant provided normalized wire stress predictions based on two data points; (1) at 1 year after post-tensioning, and (2) at forty years. The staff questioned the applicant determination of a data point at 40 years considering the plant has been operating for less than 30 years. In addition, because of other irregularities, the staff did not find the trend lines acceptable as a part of the TLAA. The staff requested a supplemental clarification to the RAI:

RAI 4.5-2 (Clarification)

The responses to RAI 4.5-2 (b) and (c) indicated that prior to 1999 tendon inspection, the applicant was not measuring the tendon forces in ANO-2. Thus, reliable data for constructing trend lines was limited to only one set of readings. Under similar situation, two licensees (applicants) have performed inspections of additional randomly selected tendons at approximately two year interval. These augmented inspections were introduced to compensate for the lack of reliable prestressing force data and to comply with the basic requirements of Subsection IWL related to prestressing tendon force measurements, and 10 CFR 50.55a(b)(viii)(B). The trend lines shown in Figures 1, 2, and 3 could not be relied upon for future projections. The applicant was requested to propose a plan or a program, that would provide a valid TLAA for each group of tendons in ANO-2 containment. In developing the program, the applicant was requested to follow the precautions and guidelines provided in NRC Information Notice 99-10 [e.g., use of raw measured (non-normalized) prestressing forces, use of tendon forces (instead of wire forces), trend line construction as provided in Attachment 3].

In the July 22, 2004 letter, the applicant stated its intention to perform the TLAA using 10 CFR 54.21(c)(1)(iii). The option (iii) would allow the applicant to use an aging management program for tracking the magnitudes of prestressing forces in ANO-2 containment. The staff would accept the applicant's proposal, provided the applicant (1) addresses the ten elements of the program (NUREG-1801 AMP X.S1) and (2) provides a description of the process that will be used for developing prestressing force trend lines.

In the letter dated September 10, 2004, the applicant provided the following information:

> Consistent with 10 CFR 54.21(c)(1)(iii), loss of tendon prestress will be adequately managed during the period of extended operation by continued implementation of tendon inspections required by ASME Code Section XI IWL. Relevant operating experience, including experience with prestressing systems described in NRC Information Notice (IN) 99-10, will be considered during inspections and data analysis. Prior to the period of extended operation, trend

lines for ANO-2 tendon prestressing forces will be developed using regression analysis in accordance with guidance provided in NRC Information Notice (IN) 99-10. If future tendon examination data diverge from the expected trend, the discrepancy will be addressed in accordance with requirements of the Containment Inservice Inspection (ISI) Program (IWE/IWL) and the current licensing basis. Specifically, if prestressing force trend lines indicate that existing prestressing forces in the containment would go below the minimum required values (MRVs) prior to the next scheduled inspection (Reference 10 CFR 50.55a(b)(2)(ix)(B) or 10 CFR 50.55a(b)(2)(viii)(B)), then systematic retensioning of tendons, a reanalysis of the containment or a reanalysis of the post-tensioning system is warranted to ensure the design adequacy of the containment.

> In summary, the ANO-2 Containment ISI Program in accordance with the requirements of ASME Code Section XI IWL will provide reasonable assurance that the effects of aging on the intended functions of tendons will be adequately managed for the period of extended operation in accordance with the provisions of 10 CFR 54.21(c)(1)(iii).

The staff finds the response acceptable as it essentially provides all information that would be provided in X.S1 of NUREG-1801 for aging management of containment prestressing tendon forces. Moreover, Attachment 2 of the letter provides a commitment that the applicant will perform its TLAA based on the measured prestressing forces during the subsequent tendon inspections.

In response to RAI 4.5-3, the applicant stated;

> ANO-2's containment inservice inspection program (Section B.1.13), in accordance with ASME Section XI, delineates the required documentation and the acceptance criteria for the prestress forces applicable for the period of extended operation. The validity of the prestress analysis, per ASME Section XI, subsection IWL is demonstrated in site documents. The adequacy of the aging management program (i.e., IWL) is assured since, as described in Section B.1.13 of the LRA, the program is consistent with the NUREG-1801 program and with current regulatory requirements. In accordance with the Statements of Consideration for the license renewal rule, the plant-specific licensing basis must be maintained during the renewal term in the same manner, and to the same extent, as during the original licensing term. Therefore, a summary table showing minimum required prestress forces for each group of tendons is not warranted in the SAR.

As discussed above, the applicant's statement in Section A.2.2.4 of the LRA, "Calculation of the acceptability of the effective prestress of the containment building post-tensioning system at 60 years has been performed to show that the containment building tendon elements will be acceptable for the period of extended operation in accordance with 54.21(c)(1)(ii)," is not correct, and should be modified to reflect the resolution of RAI 4.2-5. The applicant was requested to provide the revised Section A.2.2.4.

In the letter dated September 10, 2004, the applicant provided a revision to LRA section A.2.2.4 as follows:

A.2.2.4 CONCRETE CONTAINMENT TENDON PRESTRESS

The analysis of loss of prestress in the containment building post-tensioning system is a time-limited aging analysis. Loss of tendon prestress in the containment building post tensioning system will be managed for license renewal in accordance with 10 CFR 54.21(c)(1)(iii), by the Containment ISI Program. This program, discussed in Section A.2.1.14, includes tendon surveillance testing. Prior to the period of extended operation, trend lines for ANO-2 tendon prestressing forces will be developed using regression analysis in accordance with guidance provided in NRC IN 99-10. If prestressing force trend lines indicate that existing prestressing forces in the containment would go below the minimum required values (MRVs) prior to the next scheduled inspection (Reference 10 CFR 50.55a(b)(2)(ix)(B) or 10 CFR 50.55a(b)(2)(viii)(B)), then systematic retensioning of tendons, a reanalysis of the containment or a reanalysis of the post tensioning system is warranted to ensure the design adequacy of containment.

The staff finds the revision to LRA Section A.2.2.4 acceptable, as it provides an acceptable summary of the TLAA.

4.5.3 Conclusions

On the basis of the review of this section of the LRA, the staff concludes that the applicant's plans to perform TLAAs in accordance with 10 CFR 54.21(c)(1)(iii) is acceptable. As the applicant will adjust the trend lines based on the results of future tendon inspections, pursuant to 10 CFR 54.21(c)(1)(iii), the AMP implemented using the described process will ensure the adequacy of prestressing forces in the ANO-2 containment.

4.6 Containment Liner Plate and Penetration Fatigue Analyses

4.6.1 Summary of Technical Information in the Application

The applicant stated in Section 4.6 of the LRA that the interior surface of the containment is lined with welded carbon steel plate to provide an essentially leak-tight barrier. At the penetrations, the containment liner plate is thickened to reduce stress concentrations. The criteria in SAR Sections 3.8.1.3.4 and 3.8.1.6.3 were applied to the containment design to ensure that the integrity of the liner plate is not exceeded under design-basis accident (DBA) conditions. The applicant's evaluation of this issue for license renewal is based on an analytical assessment of the containment liner and penetrations as described in SAR Section 3.8.1.4.2, as well as on the results of recently completed containment liner plate evaluations for ANO-2.

The TLAAs for the ANO-2 reactor containment structure include containment liner and containment penetration fatigue analyses. Mechanical penetrations are leak-tight, welded assemblies. As described in SAR Section 3.8.1.4.2, containment penetrations are designed to meet the requirements of ASME Code, Section III.

The evaluation for mechanical penetrations covers the penetration assembly and the weld to the process piping, but does not include the process piping within the penetration. The closure of the pipe to the liner plate is accomplished with special heads welded to the pipe and the liner plate reinforcement. Penetration anchorage to the containment wall is designed to resist pipe rupture, seismic loads, and thermal loads.

The liner plate stress analyses indicate a conservative maximum stress of approximately 30 ksi for worst case (i.e., DBA) conditions. Stresses from normal operating cycles such as heatup and cooldown are less than 30 ksi. Using the ASME Code, Section III, Division 1 design fatigue curve, at 30 ksi the maximum cycles for the liner would be approximately 25,000. The number of normal operating cycles for the liner plate is projected to be well below this value. Therefore, the liner plate and penetrations are suitable for the cyclic loads of normal operating conditions throughout the period of extended operation. On this basis, the applicant concluded that the containment liner plate and penetration fatigue analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.6.2 Staff Evaluation

In RAI 4.6-1, the staff asked the applicant to provide the loading conditions and corresponding transient cycles used in the fatigue analysis of the containment liner plate and penetrations. In its response, the applicant clarified that it provided the loading conditions in Section 3.8.1.3 of the SAR. The applicant also stated that it did not explicitly address fatigue in the containment analysis because the calculated peak stress intensities resulted in allowable fatigue cycles, which far exceed the projected number of anticipated cycles for all operating conditions. In RAI 4.6-2, the staff requested that the applicant provide the ASME Code, Section III, CUFs and locations from the recently completed containment liner plate and containment penetration fatigue analyses, showing that these fatigue TLAAs will remain valid for the period of extended operation. In its reply, the applicant stated that, in accordance with its response to RAI 4.6-1, it did not determine ASME Code, Section III, CUFs because the allowable fatigue cycles far exceed the projected number of anticipated cycles for all operating conditions. These cycles were listed as 60 annual outdoor temperature variations, 500 cycles of reactor building interior temperature variation, and 1 thermal cycle because of a postulated DBA. The staff finds these responses reasonable and adequate because they correspond with similar results evaluated and accepted by the staff in previous LRA reviews.

4.6.3 Conclusions

On the basis of its review, the staff concludes that the applicant has provided an acceptable demonstration, pursuant to 10 CFR 54.21(c)(1)(i), that, based on fatigue TLAAs for the containment liner plate and penetration, the analyses remain valid for the period of extended operation.

The staff also concludes that Section A.2.2.5 of the FSAR Supplement contains an adequate summary description of the containment liner plate and the penetrations fatigue TLAA evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.7 Other Plant-Specific Time-Limited Aging Analyses

Other potential plant-specific TLAAs include leak before break (LBB) analyses, fracture mechanics evaluation of the RCP casing and flywheel, steam generator flow-induced vibration (FIV) analysis, qualification analyses of Alloy 600 nozzle repairs, and HELB analyses.

4.7.1 Reactor Coolant System Piping Leak Before Break Analysis

4.7.1.1 Summary of Technical Information in the Application

The NRC modified 10 CFR Part 50 General Design Criterion (GDC) 4, "Environmental and Missile Design Bases," in 1987. This change allows licensees to disregard the dynamic effects of postulated ruptures in primary coolant loop piping in the design of PWRs if LBB criteria are met. In 1990, an LBB analysis (Topical Report CEN-367-A) was performed for CE-designed nuclear steam supply systems (Reference 4.7-1). This analysis demonstrated that plant monitoring systems can detect potential leaks in the RCS primary loop piping before a postulated crack causing the leak would grow to unstable proportions during the 40-year plant life. The NRC approved this analysis in its safety evaluation (SE) dated October 30, 1990 (Reference 4.7-5). The original design basis for the ANO-2 RCS considered postulated breaks for the purposes of evaluating protection from the dynamic and environmental effects of the main coolant line (MCL) breaks. The changes to GDC 4 allowed the application of LBB criteria for the selection of MCL breaks. The NRC approved the criteria for use at ANO-2 through its SE dated June 18, 1996 (Reference 4.7-2). This application of LBB has eliminated the requirement to consider postulated breaks on the MCL in evaluating the dynamic effects on the RCS. The original LBB analysis was updated for the steam generator replacement and power uprate to demonstrate that conclusions of the original analysis remain valid.

The analysis consideration that could be time-limited is the accumulation of fatigue transient cycles over time, which could invalidate the fatigue crack growth analysis reported in CEN-367-A, Section 3.0. The crack growth rate laws were evaluated for the fatigue transients presented in Table 3-1 of CEN-367-A. Section 4.3.1 of this SER reviews the ANO-2 fatigue transient cycle definitions, demonstrating the Fatigue Monitoring Program to be capable of monitoring the Class 1 thermal fatigue design-basis transients for the period of extended operation, including the transient assumptions reported in CEN-367-A.

A review of CEN-367-A identified the fatigue crack growth analysis as a TLAA. Continued implementation of the ANO-2 Fatigue Monitoring Program provides reasonable assurance that the fatigue crack growth analysis reported in CEN-367-A will remain valid during the period of extended operation. The LBB TLAA remains valid for the period of extended operation in accordance with 10 CFR 54.21(c)(1)(i).

The applicant described its LBB analysis for the RCS in Section 4.7.1 of the LRA. The staff reviewed this section to determine if the applicant provided adequate information to meet the requirements contained in 10 CFR 54.21(c), related to the TLAA for LBB.

In CEN-367-A, Revision 000, "Leak-Before-Break Evaluation of Primary Coolant Loop Piping in Combustion Engineering Designed Nuclear Steam Supply Systems," CE describes a successful application of LBB to the RCS primary loop piping. This report provides the technical basis for evaluating two distinct postulated flaws in the RCS main-loop piping as an essential element of the LBB methodology, (1) the determination of the leakage flaw size under the normal loading condition and (2) the determination of the allowable critical flaw size under the faulted loading condition.

The applicant stated that the LBB analysis considered the accumulation of actual fatigue transient cycles over the period of extended operation that could invalidate the fatigue flaw growth analysis performed as part of the original LBB analysis. The applicant reviewed the accumulation of the applicable fatigue transient cycles to meet the TLAA definition. The applicant completed this review within the scope of the Fatigue Monitoring Program that it implemented at ANO-2. The applicant stated that the continued implementation of the Fatigue Monitoring Program provides reasonable assurance that the fatigue crack growth analysis reported in CEN-367-A will remain valid during the period of extended operation. The LRA concludes that the LBB TLAA remains valid in accordance with 10 CFR 54.21(c)(1)(i).

4.7.1.2 Staff Evaluation

In RAI-4.7.1-1, the staff asked the applicant to discuss its basis and conclusions regarding the additional crack growth predicted by the updated calculations for the end of 60 years compared to that originally predicted for 40 years. The staff confirmed that the NRC generically approved the LBB applications for the primary loop piping for Combustion Engineering Owners Group (CEOG) plants on October 30, 1990, and specifically for ANO-2 on June 18, 1996. The CEOG provides this generic LBB evaluation in CEN-367-A. There are two time-limited considerations for LBB analysis, crack growth and thermal aging. The material properties of cast austenitic stainless steel (CASS) can change over time. Thermal aging causes an elevation in the yield strength of the material and a degradation of the fracture toughness, with the degree of degradation being a function of the level of ferrite in the material. Thermal aging in CASS will continue until a saturated or fully aged point is reached.

In response to RAI-4.7.1-1, the applicant stated that the LBB fatigue crack growth analysis reported in CEN-367-A is based on 40-year design limits for RCS fatigue transient cycles. In CEN-367-A, the applicant performed fatigue crack growth to show that fatigue will not cause degradation of the pressure boundary integrity. In the fatigue crack growth analysis, the normal and upset cyclical loadings cause postulated flaws to grow. These cyclical loadings are based on reactor coolant design transient cycles. As described in Section 4.3.1 of the LRA, the number of transient cycles assumed in the original design for 40 years was found acceptable for 60 years of operation. Therefore, the postulated flaw growth in CEN-367-A (based on the RCS original design transient cycles) is unchanged for 60 years of operation. The staff finds the response acceptable and considers this issue closed.

The assessment in CEN-367-A uses the fracture toughness values of the SA-515 Grade 70 carbon steel weld in the LBB analysis, which are the lowest among all base and weld materials in the primary loop piping system. The staff has compared the fracture toughness values in CEN-367-A with the more recent information in NUREG-6177, "Assessment of Thermal Embrittlement of Cast Stainless Steels," and found that the fracture toughness data in CEN-367-A data are more conservative than the NUREG-6177 lower-bound fracture toughness curve. Therefore, because the original analysis supporting LBB bounds fully aged CASS, the analysis does not have a material property time dependency that requires further evaluation for license renewal.

For the primary loop piping, instead of revising the original analyses by taking into account the fatigue transient cycles for the period of extended operation, the applicant relied on the plant-specific Fatigue Management Program to ensure that the accumulation of the applicable fatigue transient cycles over time will not invalidate the fatigue flaw growth analysis that it performed as part of the original LBB analyses. With this program in place, which calls for constant review of the accumulation of applicable fatigue transient cycles, the applicant concluded that the continued implementation of the Fatigue Management Program will provide reasonable assurance that the RCS components within the scope of license renewal will continue to perform their intended function(s) consistent with the CLB for the period of extended operation. The staff reviewed the Fatigue Management Program and determined that the program is adequate to monitor the applicable set of transients and their limits, and to count the actual thermal cycle transients to ensure that it is within the allowable limits of the defined transients. In the event that design cycle limits are approached, the applicant will review the Fatigue Management Program and determine appropriate actions.

Based on the above evaluation, the staff agrees with the applicant's conclusion that the continued implementation of the Fatigue Management Program provides reasonable assurance that it will manage thermal fatigue for the primary loop piping and components, and therefore the analyses for this TLAA remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

Since the V.C. Summer main coolant loop weld cracking event involving Alloy 82/182 weld material, the staff has considered the effect of primary water stress-corrosion cracking on Alloy 82/182 piping welds as an operating plant issue affecting all piping with or without approved LBB applications. To resolve this issue, the industry has taken the initiative to (1) develop overall inspection and evaluation guidance, (2) assess the current inspection technology, and (3) assess the current repair and mitigation technology. An interim industry report, "PWR Materials Reliability Project Interim Alloy 600 Safety Assessment for US PWR Plants (MRP-44), Part 1: Alloy 82/182 Pipe Butt Welds," was published in April 2001 to justify the continued operation of PWRs while the industry completes the development of the final report. The staff accepted this interim report in an SE dated June 14, 2001, stating that, "Should the industry not be timely in resolving inspection capabilities to identify PWSCC in Alloy 600 welds, regulatory action may result." Little has been accomplished in the interim and the staff is pursuing further regulatory action.

4.7.1.3 FSAR Supplement

Section A.2.2.6.1 of Appendix A to the LRA provides the applicant's FSAR Supplement regarding LBB for RCS piping. The plant design cycles in the applicant's LBB analysis are consistent with those used in the fatigue crack growth analysis, and they bound the period of extended operation. In addition, the applicant's appropriate consideration of thermal aging of the CASS material constitutes the basis for the staff's acceptance of the licensee's evaluation of the LBB TLAA for the period of extended operation. On the basis of its review of the FSAR Supplements, the staff concludes that the summary description of the applicant's TLAA evaluation to address LBB for the period of extended operation is adequate and satisfies 10 CFR 54.21(d).

4.7.1.4 Conclusions

The staff concludes that, pursuant to 10 CFR 54.21(c)(1)(i), the applicant has provided an acceptable demonstration that, for the TLAA on LBB of the RCS main-loop piping, the analysis will remain valid for the period of extended operation, and the applicant will adequately manage the effects of aging on the pressure boundary function for the period of extended operation. The staff also concludes that the FSAR Supplements contain an adequate summary description of the evaluation of the TLAA for LBB, as required by 10 CFR 54.21(d).

4.7.2 Reactor Coolant Pump Code Case N-481

4.7.2.1 Summary of Technical Information in the Application

In Section 4.7.2 of the ANO-2 LRA, the applicant described an analysis based on ASME Code Case N-481 for alternative inspection criteria for RCP casings. The staff reviewed this section to determine whether the applicant provided adequate information to meet the requirements contained in 10 CFR 54.21(c) related to the TLAA for the RCP casings, as based on the criteria of ASME Code Case N-481.

The two analysis considerations of concern to the TLAA identified in the LRA are (1) loss of fracture toughness of the pump casing's CASS material of the because of thermal aging and (2) the accumulation of actual fatigue transient cycles over time that could invalidate the fatigue crack growth analysis of the ANO-2 ASME Code Case N-481 evaluation.

Because the ASME Code Case N-481 analysis assumes fully aged (saturated) properties, the LRA concludes that the TLAA needs no further evaluation for license renewal to address concerns with material property changes. The LRA describes a review of the accumulation of the applicable fatigue transient cycles that the applicant performed to meet the TLAA definition. The applicant performed this review within the scope of the Fatigue Monitoring Program that it implemented at ANO-2. The applicant stated that the continued implementation of the FMP provides reasonable assurance that the fatigue crack growth analysis will remain valid during the period of extended operation. The LRA concludes that the TLAA will remain valid in accordance with 10 CFR 54.21(c)(1)(i).

The applicant evaluated a demonstration of compliance of the primary loop pump casings to ASME Code Case N-481 for ANO-2. This analysis considers thermal aging of the CASS pump casings and fatigue crack growth. Because these evaluations could be influenced by time, the Code Case N-481 analysis is a potential TLAA.

The first analysis consideration that could be time limited is the material properties of CASS. Such steels used in the RCS are subject to thermal aging during service. Since the Code Case N-481 analysis relied on fully aged (saturated) stainless steel material properties, the analysis does not have a material property time dependency that requires further evaluation for license renewal.

In addition, the accumulation of actual fatigue transient cycles over time could invalidate the fatigue crack growth analysis of the ANO-2 Code Case N-481 evaluation. Section 4.3.1 of this SER discusses a review of the ANO-2 fatigue transient cycle definitions, demonstrating that the

Fatigue Monitoring Program adequately monitors thermal fatigue design transients, including the transient cycle assumptions reported in the ANO-2 Code Case N-481 evaluation, for the period of extended operation. The continued implementation of the Fatigue Monitoring Program provides reasonable assurance that the ANO-2 Code case N-481 fatigue crack growth analysis will remain valid during the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7.2.2 Staff Evaluation

There are two time-limited considerations for the ASME Code Case N-481 analysis. First, the material properties of CASS can change over time. Thermal aging of the pump casing material causes an elevation in the yield strength material and a degradation of the fracture toughness, with the degree of degradation being a function of the level of ferrite in the material. Thermal aging in CASS will continue until a saturated or fully aged point is reached. The applicant used fully aged (saturated) properties in its analysis and concluded that it addressed the effects of thermal aging on material properties of the CASS RCP casings for the period of extended operation. In RAI 4.7.2-1, the staff asked the applicant to discuss whether the properties considered in the analysis are the same bounding properties that it used for fully aged CASS materials, as assumed in CEN-367-A. If the applicant considered other material properties for the ASME Code Case N-481 analysis, the staff asked the applicant to justify its use of those properties.

In response to RAI 4.7.2-1, the applicant stated that, because of the variety of materials used at the different plants, it used bounding values from participating plants in CEN-367-A for the material properties for stainless steel safe ends. In contrast, the applicant completed the ASME Code Case N-481 evaluation specifically for ANO-2, and thus used ANO-2 specific material properties for the RCP casings. The staff finds the response acceptable and considers this issue closed.

The applicant performed a qualitative assessment in order to show that the plant-specific Fatigue Monitoring Program can programmatically manage the assumptions, including the fatigue cycles, in the existing analyses for the period of extended operation. In RAI-4.7.2-2, the staff asked the applicant to discuss the additional crack growth that the updated calculations predicted for the end of 60 years and compare the crack growth to that originally predicted for 40 years. The staff also asked the applicant to provide the criteria or basis for concluding that this amount of additional crack growth is sufficiently small to justify continued application of ASME Code Case N-481.

In response to RAI-4.7.2-2, the applicant stated that it did not update the ASME Code Case N-481 calculation for 60 years. As described in Section 4.7.2 of the ANO-2 LRA, the ASME Code Case N-481 analysis remains valid for the period of extended operation in accordance with 10 CFR 54.21(c)(1)(i). In the ASME Code Case N-481 evaluation, the applicant determined fatigue crack growth in order to assure that fatigue will not cause degradation of pressure boundary integrity. In the fatigue crack growth analysis, the normal and upset cyclical loadings cause postulated flaws to grow. These cyclical loadings are based on RCS design transient cycles. As described in Section 4.3.1 of the LRA, the number of transient cycles assumed in the original design for 40 years was found acceptable for 60 years of operation (i.e., the number of transients used for 40 years of operation are still bounding for 60 years of operation). Therefore, the postulated flaw has no additional crack growth when extending the period of operation to 60 years. The staff finds the response acceptable and considers this issue closed.

4.7.2.3 FSAR Supplement

Section A.2.2.6.2 of Appendix A to the LRA provides the applicant's FSAR Supplement summary description for the TLAA on the RCP casings, as performed in accordance with the ASME Code Case N-481 criteria. The plant design cycles considered in the applicant's analysis are consistent with those it used in the fatigue crack growth analysis and bound the period of extended operation. In addition, the applicant's appropriate consideration of thermal aging of the CASS material constitutes the basis for the staff acceptance of the licensee's evaluation of the TLAA for the period of extended operation. On the basis of its review of the FSAR Supplements, the staff concludes that the summary description of the applicant's TLAA evaluations to address the ASME Code Case N-481 evaluation for the period of extended operation is adequate and satisfies 10 CFR 54.21(d).

4.7.2.4 Conclusions

The staff concludes that, pursuant to the acceptability criteria of 10 CFR 54.21(c)(1)(i), the applicant has provided an acceptable demonstration that, for the TLAA on the RCP casings, as performed in accordance with the ASME Code Case N-481 criteria, the analysis will remain valid for the period of extended operation for ANO-2, and the applicant will adequately manage the effects of aging on the pressure boundary function for the period of extended operation. The staff also concludes that the FSAR Supplement contains an adequate summary description of the TLAA evaluation for the RCP casings, as required by 10 CFR 54.21(d).

4.7.3 Reactor Coolant Pump Flywheel

4.7.3.1 Summary of Technical Information in the Application

In Section 4.7.3 of the ANO-2 LRA, the applicant describes an analysis of fatigue crack initiation and growth for the RCP flywheel. The staff reviewed this section to determine whether the applicant provided adequate information to meet the requirements of 10 CFR 54.21(c)(1), as the information relates to the TLAA for the RCP flywheel.

To reduce the RCP flywheel inspection frequency and scope, ANO-2 submitted a topical report in 1995 that uses a fatigue crack growth calculation to evaluate the effects of cyclic stresses and fatigue. The NRC staff reviewed and approved the topical report on May 21, 1997. Crack growth calculations were based on an assumed 4,000 cycles of RCP startups and shutdowns rather than a specific time period of operation. The LRA states that the number of cycles from actual plant operating conditions through the end of the extended period of operation will be much less than the assumed 4,000 cycles. On this basis, the applicant originally concluded that the analysis of the 1995 topical report applies to the extended period of plant operation, and that the flywheel analysis is not a time-limited analysis from the standpoint of the license renewal application.

In the applicant's response to RAI 4.7.3-1, dated September 10, 2004 (Entergy Letter No. 2CAN090402), the applicant modified its position and stated that it will treat the low-cycle fatigue crack growth analysis for ANO-2 RCP flywheels as a TLAA for the ANO-2 LRA.

4.7.3.2 Staff Evaluation

In the ANO-2 LRA, the applicant concluded that the RCP flywheel is not a TLAA. The basis for this conclusion is a 1997 safety evaluation of a fatigue crack growth analysis that was presented in a Combustion Engineering Owner's Group topical report. This safety evaluation allowed the licensee to lengthen the RCP flywheel inspection period for ANO, Units 1 and 2 and five other units. The fatigue crack growth analysis for ANO, Units 1 and 2 is based on 4,000 RCP startup and shutdown cycles. Table 4.1-3 of the NUREG-1800, *Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants*, identifies that low-cycle fatigue crack growth analyses for PWR RCP flywheels are TLAAs for PWR-designed light-water reactors. In RAI 4.7.3-1, the staff requested that the applicant provide the TLAA for the RCP Flywheel for ANO Unit 2, and include the justification for why 4,000 RCP startup and shutdown cycles remain bounding through the end of the extended period of operation for ANO-2.

In the applicant's response to RAI 4.7.3-1, dated September 10, 2004, the applicant has states that it will treat the low-cycle fatigue crack growth analysis for ANO-2 RCP flywheels as a TLAA for the ANO-2 LRA and that the 4000 plant startup/shutdown cycles assumed in the crack growth analysis remain bounding for the number of plant startup/shutdown cycles (RCP start/trip cycles) assumed for the facility through both 40 years and 60 years of licensed (500 plant startup/shutdown cycles is assumed in design basis for both the current operating term and extended operating term). The applicant concluded that the the low-cycle fatigue crack growth analysis for the RCP flywheels meets the TLAA analysis acceptability criteria of 10 CFR 54.21(c)(1)(i).

Section 5.2.6 of the ANO-2 FSAR provides the design basis for how the applicant's design, fabrication, testing, inspection, and analysis program for the RCP flywheels is designed to conform to staff's design, fabrication, testing, inspection, and analysis criteria that are recommended in NRC Regulatory Guide 1.14, Revision 1, *Reactor Coolant Pump Flywheel Integrity (August 1975).* Subsection 5.2.6.2 to Section 5.2.6 of the ANO-2 FSAR indicates that a 1.0 inch deep crack is assumed to occur in the keyway of the limiting flywheel disc and that the critical crack size for the flywheel is 1.8 inches. The low-cycle fatigue crack growth analysis for the RCP flywheels demonstrates that the postulated flaw in the analysis will not grow in excess of the critical crack size for the flywheel disc, even when the flywheels have been subjected to the change in the stress intensity factor for the flywheel discs associated with 4000 RCP startup/shutdown cycles. Since this bounds the number of RCP startups/shutdown cycles assumed for both the current operating period and the proposed period of extended operation, the staff concludes that the low-cycle fatigue crack growth analysis for the RCP flywheels meets the acceptance criterion for TLAAs in 10 CFR 54.21(c)(1)(i), in that the analysis remains bounding for the period of extended operation.

4.7.3.3 FSAR Supplement

Appendix A of the applicant's FSAR supplement does not address the fatigue analysis for the reactor coolant pump flywheel. The LRA states that the existing analysis of the 1995 topical report does not involve time limiting assumptions which would restrict application to only the current operating term or preclude application to the extended period of plant operation. The staff concluded that the fatigue analysis for the reactor coolant pump flywheel is a TLAA, and that the applicant should submit the TLAA for staff evaluation. In the applicant's response to RAI 4.7.3-1, dated September 10, 2004, the applicant stated that it will treat the low-cycle fatigue crack growth analysis for ANO-2 RCP flywheels as a TLAA for the ANO-2 LRA. The applicant provided the following FSAR Supplement summary description (i.e., Section A.2.2.6.6, *RCP Motor Flywheel*, of Appendix A to the ANO-2 LRA) for the TLAA on the TLAA on the low-cycle fatigue crack growth analysis for the RCP flywheels.

> A.2.2.6.6 RCP Motor Flywheel
>
> The flaw growth analysis associated with the reactor coolant pump motor flywheel is conservatively treated as a time-limited aging analysis. The analysis addresses the growth of pre-existing cracks subjected to 4,000 reactor coolant pump motor startup or shutdown cycles, which exceeds by a factor of eight the number of RCP cycles projected through the period of extended operation. Therefore, the flaw growth analysis remains valid for the period of extended operation.

The applicant's FSAR Supplement summary description provides a summary description basis for the low-cycle fatigue crack growth analysis that is consistent with the staff's evaluation that is discussed in Section 4.7.3.2 of this SER. The FSAR Supplement summary description for the TLAA on the RCP Motor Flywheel is therefore acceptable to the staff, and satisfies the criterion for FSAR Supplement summary descriptions in 10 CFR 54.21(d). Section 5.2.6 of the ANO-2 FSAR provides additional details and information on the applicant's inspection programs and structural integrity analyses for the RCP flywheels, as implemented in conformance with the NRC's recommended guidelines in Regulatory Guide 1.14, Revision 1, *Reactor Coolant Pump Flywheel Integrity (August 1975).*

4.7.3.4 Conclusions

The staff concludes that the applicant has provided an acceptable demonstration pursuant to 10 CFR 54.21(c)(1)(i) that, for the TLAA on the RCP motor flywheel, the analysis remains valid for the period of extended operation.

The staff also concludes that the FSAR supplements contain an adequate summary description of this TLAA evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.7.4 Steam Generator Tubes—Flow-Induced Vibration

4.7.4.1 Summary of Technical Information in the Application

TLAAs applicable to the steam generators include analyses of steam generator tube FIV. The ANO-2 steam generator design life extends to 2040, as they were installed in 2000. This exceeds the period of extended operation sought through this LRA. Therefore, the steam generator FIV analysis remains valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7.4.2 Staff Evaluation

The ANO-2 replacement steam generators were installed in 2000. The applicant states that the design life of the replacement steam generators extends to 2040, which exceeds the period of extended operation sought in its LRA. The applicant concludes that the steam generator FIV analysis remains valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

In addition to a valid FIV analysis, the ANO-2 steam generators are designed to minimize potential FIV occurring on tubes. Steam generator tubes are supported to minimize excessive vibration which could be detrimental to their structural integrity. The impact of FIV will most likely cause tube wear at the intersection of antivibration bars and the tubes. However, periodic inspections required by the applicant's Steam Generator Integrity Program will monitor and detect any potential tube wear. On the basis of the information the applicant submitted, the staff concludes that the applicant's TLAA of FIV on steam generator tubes meets the acceptance criteria stated in 10 CFR 54.21(c)(1)(i) and 10 CFR 54.21(c)(1)(iii) and is therefore acceptable.

4.7.4.3 FSAR Supplement

The applicant provided the FSAR Supplement summary descriptions for the TLAA on the Steam Generator Tubes - Flow-Induced Vibration in Section A.2.2.6.3 of Appendix A to the LRA. The staff reviewed the FSAR Supplement summary descriptions for the TLAA, as given in Section A.2.2.6.3 of Appendix A to the LRA. The staff determined that the FSAR description for the TLAA provides an adequate summary of the evaluation of the TLAA for the Steam Generator Tubes - Flow-Induced Vibration. This commitment will ensure compliance with the requirements of 10 CFR 54.21(c)(1)(i). Therefore, the staff has reviewed the to the FSAR Supplement summary description for this TLAA and concludes that it provides an adequate summary description of the TLAA, as required by 10 CFR 54.21(d).

4.7.4.4 Conclusions

The staff concludes that, pursuant to 10 CFR 54.21(c)(1)(i), the applicant has provided an acceptable demonstration that, for the TLAA on FIV of the steam generator tubes, the analysis will remain valid for the period of extended operation for ANO-2, and the applicant will adequately manage the effects of aging on the pressure boundary function for the period of extended operation. The staff also concludes that the FSAR Supplements contain an adequate summary description of the evaluation of TLAA for FIV, as required by 10 CFR 54.21(d).

4.7.5 Alloy 600 Nozzle Repairs

4.7.5.1 Summary of Technical Information in the Application

In 2000, nondestructive examination evaluations revealed that a number of pressurizer heater penetrations, as well as resistance temperature detector (RTD) and pressure measurement nozzle penetrations on the RCS hot leg, had developed leaks. The repair for the pressurizer heater penetration replaced the pressure boundary weld on the inside surface of the pressurizer nozzle with an outer diameter (OD) weld attached to a temper-bead weld pad on the pressurizer

OD. The hot-leg piping penetration modification consisted of removing a portion of the old RTD or pressure tap by cutting it near the outer wall of the RCS piping and replacing it with a new nozzle welded on the outside surface of the RCS piping. The applicant performed a fracture mechanics evaluation in order to evaluate the potential for a crack in the remaining pressurizer and RCS hot-leg penetration welds to propagate into the pressurizer vessel or hot-leg pipe wall. The applicant used transient cycles in the crack growth evaluations, which it assumed for a 40-year plant lifetime. To prevent further penetration leakage, the applicant replaced all primary piping RTD nozzles at ANO-2. The applicant qualified the replacement nozzles and attachment welds for structural adequacy in accordance with ASME code criteria. This analysis included a simplified fatigue evaluation which considered cyclic loads from pressure, thermal gradients, and mechanical loads.

As discussed in Section 4.3.1 of the LRA, the applicant has completed a review of the ANO-2 fatigue transient cycle definitions. The Fatigue Monitoring Program will monitor thermal fatigue design-basis transients, including those assumed in the analysis of the Alloy 600 nozzle repairs, for the period of extended operation. The continued implementation of the Fatigue Monitoring Program provides reasonable assurance that the fatigue crack growth analysis for the repairs will remain valid during the period of extended operation. Similarly, the fatigue analysis for the replacement nozzles and attachment welds remains valid for the period of extended operation. This result demonstrates that the Alloy 600 nozzle repair TLAAs remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7.5.2 Staff Evaluation

In a nozzle repair technique, the leaking (cracked) Alloy 600 nozzle is cut outboard from the partial-penetration J-groove weld that was used to join the nozzle to the RCS hot-leg piping or pressurizer shell. The section of the nozzle near the outer surface of the pressure boundary component is removed and replaced with a short Alloy 690 nozzle section. The inserted Alloy 690 nozzle section is then welded to the pressure boundary component's outside surface. This half-nozzle repair method leaves a short section of the original nozzle attached to the inside surface with the J-groove weld and exposes the ferritic (i.e., low-alloy steel or carbon steel) pressure boundary material to the borated water conditions of the reactor coolant.

In Section 4.7.5 of the LRA, the applicant indicated that it performed a fracture mechanics analysis to support the ANO-2 pressurizer heater penetrations. The fracture mechanics analysis justifies the acceptability of indications in the original J-groove weld based on a postulated flaw size and flaw growth, considering the applicable design cycles. Based on the results of the analysis, the applicant concluded that the postulated flaw size for the worst-case instrument nozzle is acceptable for the remaining design life of the plant.

In RAI 4.7.5-1, the staff requested that the applicant demonstrate that the designs of repaired nozzles will have sufficient structural integrity against the loss of material by corrosion and will meet the minimum wall thickness requirements through the expiration of the period of extended operation.

In response to RAI 4.7.5-1, the applicant stated that it completed analyses to estimate the corrosion rate assuming a repaired nozzle has a through-wall crack, and the crevice between the repaired nozzle and underlying ferritic steel will be exposed to aerated borated water. The service lifetimes for repairs to the hot-leg pipe nozzles, pressurizer nozzles, and pressurizer heater sleeves are 76, 56, and 196 years, respectively, before they would exceed ASME Code limits. The most limiting service lifetime is that of 56 years for the pressurizer nozzle repair. The 56-year lifetime from the date of the nozzle repair extends the service life beyond the period of extended operation. Therefore, loss of material by corrosion will not impair the ability of the repaired nozzles to maintain sufficient structural integrity for the period of extended operation.

In RAI 4.7.5-2, the staff asked the applicant to justify and validate the CEOG conclusion that the growth of the existing flaw in the original Alloy 82/182 J-groove weld material by stress-corrosion cracking into the carbon steel or low-alloy steel base metal is not a plausible effect during the period of extended operation.

In response to RAI 4.7.5-2, the applicant stated that the repaired nozzles will have cracks in the Alloy 600 nozzles or the partial penetration attachment welds remaining after completing the repair. Since residual stresses from the welding will remain, these cracks may continue to propagate through the nozzle/weld metal by stress-corrosion cracking to the carbon or low-alloy steel base metal. Further growth into the carbon or low-alloy steel base metal is unlikely since low oxygen levels resulting from PWR water chemistry will result in corrosion potentials below the critical cracking potential in a high-temperature environment. As described in Section B.1.30.3 of the LRA, the applicant based the ANO-2 Primary Water Chemistry Control Program on the Electric Power Research Institute TR-105714, which requires stringent oxygen controls. This program will continue into the period of extended operation. Therefore, the applicant concluded that the ANO-2 Primary Water Chemistry Program will provide an environment which limits the corrosion potential of the applicable material below the critical cracking potentials, and stress-corrosion cracking will not cause growth of the existing flaw into the carbon steel or low-alloy steel base metal. The staff finds the response acceptable and considers this issue closed.

It should be noted that Westinghouse Electric Corp. has revised CE NPSD-1198-P, Revision 00, since the staff issued its review of the report (as given in the staff's SE of February 8, 2002), and since the applicant issued its response (October 10, 2002). The revisions to the topical report address potential issues with the original boric acid wastage analysis for the half-nozzle designs that came up as a result of the boric acid corrosion (wastage) event of the Davis-Besse RV head, and they also address a design calculation error Westinghouse discovered in the original fatigue crack growth analysis for the half-nozzle designs. The Class 2 proprietary report, WCAP-15973-P, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," issued November 2002, provides the revisions, which the applicant submitted to the NRC for review and approval in letter CEOG-02-243, dated November 11, 2002. This report applies to the ANO-2 half-nozzle designs.

4.7.5.3 FSAR Supplement

The applicant provided the FSAR Supplement summary descriptions for the TLAAs on the Alloy 600 nozzle repairs in Section A.2.2.6.4 of Appendix A to the LRA. The staff reviewed the FSAR Supplement summary descriptions for the TLAA, as given in Section A.2.2.6.4 of Appendix A to the LRA. The staff determined that the FSAR descriptions for the TLAA on the nozzle repairs provide an adequate summary of the evaluation of the TLAA for the ANO-2 nozzle repairs. This commitment will ensure compliance with the requirements of 10 CFR 54.21(c)(1) and 10

CFR 50.55a(a)(3). The staff therefore concludes that the FSAR Supplement summary descriptions for the TLAA are acceptable.

4.7.5.4 Conclusions

The staff concludes that the applicant has provided an adequate demonstration pursuant to 10 CFR 54.21(c)(1)(ii) that, for the nozzle repairs TLAA, the applicant has projected the analyses to the end of the period of extended operation. The staff also concludes that the FSAR Supplements contain an adequate summary description of the evaluation of this TLAA for the period of extended operation, as required by 10 CFR 54.21(d).

4.7.6 High-Energy Line Break Analyses

4.7.6.1 Summary of Technical Information in the Application

The applicant stated in Section 4.7.6 of the LRA that, in accordance with GDC 4, it has taken special measures in the design and construction of ANO-2 to protect SSCs required to place the reactor in a safe, cold-shutdown condition from the dynamic effects associated with the postulated rupture of piping. The applicant used RG 1.46, "Protection Against Pipe Whip Inside Containment," in establishing the design criteria for piping systems inside the containment. As defined in SAR Section 3.6.2.1, the applicant determined the postulated break locations for ASME Code, Section III, Class 1 piping, in part, using any intermediate locations between terminal ends where the CUF derived from the piping fatigue analysis under the loadings associated with specified seismic events and operational plant conditions exceeded 0.1 (Reference 4.7-3). As discussed in Section 4.3 of this SER, these fatigue evaluations are TLAAs since they are based on a set of design transients that are dependent on the life of the plant.

Fatigue evaluations for Class 1 mechanical components at ANO-2, as described in Section 4.3.1 of the LRA, demonstrate ample margin exists between the projected and analyzed number of thermal cycles for all Class 1 components for the period of extended operation. Therefore, the analyzed usage factors the applicant employed for the current HELB location determinations remain valid for the period of extended operation.

In addition, the applicant stated that ANO-2 monitors transient cycles that contribute to fatigue usage in accordance with requirements in the ANO-2 TSs, Section 6.8.4(b). The continued implementation of the ANO-2 Fatigue Monitoring Program, which the applicant discussed in Appendix B to the LRA, also provides reasonable assurance that the ANO-2 HELB analyses will remain valid during the period of extended operation. The applicant concluded that this result demonstrates that the HELB TLAA remains valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7.6.2 Staff Evaluation

In RAI 4.7.6-1, the staff asked the applicant to indicate that it reevaluated the surge line fatigue TLAA to determine if additional intermediate pipe breaks needed to be postulated at locations where the CUF may exceed the pipe break postulation criterion for Class 1 piping (CUF=0.1), stated in SAR Section 3.6.2.1, during the period of extended operation. In its response, the applicant stated that the number of RCS transients assumed in the original design is greater than the number projected for 60 years of operation, and therefore the CUFs will not exceed the criterion for intermediate breaks and remain valid for the period of extended operation. Since the CUFs do not change, no new break locations need to be postulated. The staff concurs with the applicant's conclusion that it need not postulate any new breaks.

The staff has reviewed the technical information in Section 4.7.6 of the LRA regarding the fatigue TLAAs for the postulation of HELB in ASME Code, Section III, Class 1 piping, including the response to RAI 4.7.6.1. The staff finds the information adequate because the applicant has demonstrated that the fatigue TLAAs which form the basis for postulating HELBs, in accordance with SAR Section 3.6.2.1, will remain valid during the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7.6.3 FSAR Supplement

The applicant provided the FSAR Supplement summary descriptions for the TLAAs on the High-Energy Line Break Analyses in Section A.2.2.6.5 of Appendix A to the LRA. The staff reviewed the FSAR Supplement summary descriptions for the TLAA, as given in Section A.2.2.6.5 of Appendix A to the LRA. The staff determined that the FSAR description for the TLAA provides an adequate summary of the evaluation of the TLAA for the High-Energy Line Break Analyses. This commitment will ensure compliance with the requirements of 10 CFR 54.21(c)(1)(i). Therefore, the staff has reviewed the to the FSAR Supplement summary description for this TLAA and concludes that it provides an adequate summary description of the TLAA, as required by 10 CFR 54.21(d).

4.7.6.4 Conclusions

Section A.2.2.6.5 of the LRA provides the applicant's supplement for the ANO-2 FSAR regarding the HELB fatigue TLAA of ASME Code, Section III, Class 1 piping. The staff has reviewed the supplemental section and finds it acceptable because it provides a reasonable summary of the information the applicant presented in Section 4.7.3 of the LRA.

On the basis of its review, the staff concludes that the applicant has provided an adequate demonstration, pursuant to 10 CFR 54.21(c)(1)(i), that the TLAAs that form the basis for postulating HELB remain valid for the period of extended operation.

The staff also concludes that the FSAR Supplement contains an appropriate summary description of the HELB TLAA evaluation for the period of extended operation, as required by 10 CFR 54.21(d).

4.8 Conclusions for Time-Limited Aging Analyses

The staff has reviewed the information in Section 4, "Time-Limited Aging Analysis", of the LRA. On the basis of its review, the staff concludes that the applicant has provided an adequate list of TLAAs, as defined in 10 CFR 54.3. Further, the staff concludes that the applicant has demonstrated that (1) the TLAAs will remain valid for the period of extended operation, as required by 10 CFR 54.21(c)(1)(i), (2) the TLAAs have been projected to the end of the period of extended operation, as required by 10 CFR 54.21(c)(1)(ii), or (3) that the aging effects will be adequately managed for the period of extended operation, as required by 10 CFR 54.21(c)(1)(iii). The staff has also reviewed the FSAR Supplements for the TLAAs and finds that the FSAR Supplement contains descriptions of the TLAA's sufficient to satisfy the requirements of 10 CFR 54.21(d). In addition, the staff concludes that no plant-specific exemptions are in effect that are based on TLAA's, as required by 10 CFR 54.21(c)(2).

With regard to these matters, the NRC staff has concluded that there is reasonable assurance that the activities authorized by the renewed licenses will continue to be conducted in accordance with the current licensing basis, and that any changes made to the ANO-2 current licensing basis in order to comply with 10 CFR 54.29(a) are in accord with the Act and the Commission's regulations.

5. REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The NRC staff issued its safety evaluation report (SER) related to the renewal of operating license for Arkansas Nuclear One, Unit 2 on November 5, 2004. On December 1, 2004, the applicant presented its license renewal application, and the staff presented its review findings to the ACRS Plant License Renewal Subcommittee. The staff reviewed the applicant's comments on the SER and completed its review of the license renewal application. The staff's evaluation is documented in an SER that was issued by letter dated April 7, 2005.

During the 522nd meeting of the ACRS, May 5-6, 2005, the ACRS completed its review of the Arkansas Nuclear One, Unit 2 license renewal application and the NRC staff's SER. The ACRS documented its findings in a letter to the Commission dated May 13, 2005. A copy of this letter is provided on the following pages of this SER.

ACRSR-2124

May 13, 2005

The Honorable Nils J. Diaz
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 2005-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL APPLICATION FOR ARKANSAS NUCLEAR ONE, UNIT 2

Dear Chairman Diaz:

During the 522nd meeting of the Advisory Committee on Reactor Safeguards, May 5-6, 2005, we completed our review of the license renewal application for Arkansas Nuclear One, Unit 2 (ANO-2), and the associated final Safety Evaluation Report (SER) prepared by the NRC staff. Our Plant License Renewal Subcommittee also reviewed this matter during a meeting on December 1, 2004. During our review, we had the benefit of discussions with representatives of the NRC staff and Entergy Operations, Inc. (Entergy). We also had the benefit of the documents referenced. This report fulfills the requirements of 10 CFR 54.25 that the ACRS review and report on all license renewal applications.

CONCLUSION AND RECOMMENDATION

1. The programs established and committed to by the applicant to manage age-related degradation provide reasonable assurance that ANO-2 can be operated in accordance with its current licensing basis for the period of extended operation without undue risk to the health and safety of the public.

2. The Entergy application for renewal of the operating license for ANO-2 should be approved.

BACKGROUND AND DISCUSSION

ANO-2 is a Combustion Engineering pressurized water reactor rated at 3026 MWt, enclosed in a large dry containment building. The current power rating includes a 7.5% power uprate implemented in 2002. The ANO-2 steam generators were replaced with new Westinghouse Delta steam generators with Alloy 690 tubing in conjunction with this power uprate.

Entergy requested renewal of the ANO-2 operating license for 20 years beyond the current license term, which expires on July 17, 2018. In the final SER, the staff documents its review of the license renewal application and other information submitted by Entergy and obtained during the audits and inspections at the plant site. The staff reviewed the completeness of the applicant's identification of structures, systems, and components (SSCs) that are within the scope of license renewal; the integrated plant assessment process; the applicant's identification of plausible aging mechanisms associated with passive, long-lived components; the adequacy of the applicant's aging management programs; and the identification and assessment of time-limited aging analyses (TLAAs).

The ANO-2 application demonstrates consistency with the Generic Aging Lessons Learned (GALL) Report or documents deviations from the approaches specified in that report. The ANO-2 application is the second one evaluated by the staff using the new audit and review process developed to confirm consistency with, and the acceptability of deviations from, the GALL Report. The new process requires that more review activities be conducted at the site. As in the first application, this approach has resulted in more effective interactions between the applicant and the staff and has significantly reduced requests for additional information (RAIs).

During its review, the staff identified several components that the applicant should have included in the scope of license renewal but did not. The applicant subsequently brought them into scope. The staff concluded that these omissions were the result of minor oversights or different interpretations of the scoping methodology, and not an indication of process problems. The staff also concluded that the applicant's scoping and screening processes have successfully identified SSCs within the scope of license renewal and subject to an aging management review. We agree with these conclusions.

The applicant performed a comprehensive aging management review of all SSCs within the scope of license renewal. In the application, Entergy describes 34 aging management programs for license renewal, including existing, enhanced, and new programs. We agree with the staff's conclusion that these programs are adequate.

Implementation is key to effective aging management programs. Although the applicant's Structures Monitoring-Masonry Wall Program is consistent with the GALL Report, the staff's audit of this program revealed that the initial baseline examinations were not documented properly, the first 5-year reexamination was not performed, and qualifications for personnel responsible for walkdowns were not established. The Annual Assessment Letter for ANO, Units 1 and 2, dated March 3, 2004, had already identified a substantive cross-cutting issue concerning problem identification and resolution. Based on the Annual Assessment Letter dated March 2, 2005, the weaknesses in the ANO-2 Problem Identification and Resolution Program appear to have been corrected. Maintaining an effective problem identification and resolution program is critical to the success of the aging management programs.

As in previous reviews, we questioned the adequacy of relying on opportunistic inspections of inaccessible buried piping and tanks, in lieu of periodic inspections at a plant-specific frequency, as specified in the GALL Report. The applicant has committed to enhance its Buried Piping Inspection Program by performing an inspection within 10 years of entering the period of extended operation unless an opportunistic inspection has occurred within this 10-year period. This program enhancement is appropriate.

The applicant identified and reevaluated systems and components requiring TLAAs for 20 more years of operation. The applicant's analyses of reactor vessel embrittlement (upper shelf energy, pressurized thermal shock, and pressure-temperature limits), independently verified by the staff, demonstrate that the limiting beltline materials will satisfy the acceptance criteria at 48 effective full-power years (EFPYs). This value corresponds to a constant capacity factor of 80% for 60 years. We questioned the use of 48 EFPYs, rather than the 54 EFPYs used by other applicants to bound 60 years of operation. Given the current performance of the fleet, 54 EFPYs seems to be a more appropriate value for 60 years of operation. The staff independently verified that the upper shelf energy and pressurized thermal shock acceptance criteria would still be met at 54 EFPYs.

In 2000, nondestructive examinations revealed a number of leaks in pressurizer and hot-leg penetration nozzles. The applicant implemented repairs using the half-nozzle repair technique. The applicant evaluated the potential for existing flaws in the remaining pressurizer and hot-leg penetration welds to propagate into the pressurizer or hot leg. The applicant has performed a TLAA to bound the period of extended operation and has demonstrated that stress corrosion cracking will not cause existing flaws to propagate into the carbon steel or low-alloy steel base metal.

Since a shroud prevents a complete 360° bare metal visual inspection of some of the control rod drive mechanism (CRDM) penetrations, the applicant performed alternative eddy current and volumetric inspections. Although these inspections did not identify any cracking or leakage, ANO-2 is ranked as highly susceptible to CRDM cracking. The applicant has scheduled the procurement of a new reactor vessel head in 2006. Meanwhile, the applicant plans to modify the shroud to allow increased access for visual examinations.

We agree with the staff that no issues related to the matters described in 10 CFR 54.29(a)(1) and (a)(2) preclude renewal of the operating license for ANO-2. The programs established and committed to by Entergy provide reasonable assurance that ANO-2 can be operated in accordance with its current licensing basis for the period of extended operation without undue risk to the health and safety of the public. The Entergy application for renewal of the operating license for ANO-2 should be approved.

Sincerely,

/RA/

Graham B. Wallis
Chairman

References

1. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report Related to the License Renewal of the Arkansas Nuclear One, Unit 2," April 2005
2. Entergy Operations Inc., "License Renewal Application Arkansas Nuclear One - Unit 2," October 2003
3. U.S. Nuclear Regulatory Commission, "Draft Safety Evaluation Report Related to the License Renewal of the Arkansas Nuclear One, Unit 2," November 2004
4. U.S. Nuclear Regulatory Commission, "Arkansas Nuclear One, Unit 2 - NRC License Renewal Scoping and Screening Inspection Report 05000368/2004-06," April 19, 2004

5. Information Systems Laboratories, Inc., "Audit and Review Report for Plant Aging Management Reviews and Programs, Arkansas Nuclear One - Unit 2," July 29, 2004

6. CONCLUSIONS

The staff of the U.S. Nuclear Regulatory Commission (NRC or Commission) reviewed the license renewal application for Arkansas Nuclear One, Unit 2, in accordance with Commission regulations and NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," dated July, 2001. Title 10, Section 54.29, of the Code of Federal Regulations (10 CFR 54.29) provides the standards for issuance of a renewed license.

On the basis of its evaluation of the license renewal application, the NRC staff has determined that the requirements of 10 CFR 54.29(a) have been met.

The NRC staff notes that any requirements of Subpart A of 10 CFR Part 51 are documented in Supplement 19 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Arkansas Nuclear One - Unit 2. Final Report", dated April 2005.

APPENDIX A: COMMITMENTS FOR LICENSE RENEWAL

During the review of the Arkansas Nuclear One, Unit 2, LRA by the NRC staff, the applicant made commitments related to aging management programs (AMPs) to manage aging effects of structures and components (SCs) prior to the period of extended operation. The following table lists these commitments, along with the implementation schedule and the source of the commitment.

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Alloy 600 Program		
1	ANO-2 will submit a description of the Alloy 600 Aging Management Program, which includes the inspection plan, to the NRC staff for review and approval.	At least 24 months prior to the period of extended operation	Letter 2CAN090402, Attachment 2, pg 6.
2	The FSAR Supplement A.2.1.1 will be revised to state the following: The Alloy 600 Aging Management Program will manage aging effects of alloy 600/690 items and alloy 52/152 and 82/182 welds in the reactor coolant system that are not addressed by the Reactor Vessel Head Penetration Inspection Program, Section A.2.1.21, and the Steam Generator Integrity Program, Section A.2.1.26. This program will detect primary water stress corrosion cracking (PWSCC) by using the examination and inspection requirements of ASME Section XI, as augmented by the commitments made by the applicant in NRC correspondence.	Upon issuance of the renewed license.	Letter 2CAN090403, Attachment 1, pg 2 Letter 2CAN090403, Attachment 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
3	A description of the Alloy 600 Aging Management Program, which includes the inspection plan, will be submitted to the NRC for review and approval. The submittal date will be at least 24 months prior to the period of extended operation.	At least 24 months prior to the period of extended operation	Letter 2CAN090403, Attachment 2, pg 1.
	Buried Piping Inspection Program		
4	The Buried Piping Inspection Program will include preventive measures to mitigate corrosion and periodic inspection to manage the effects of corrosion on buried carbon steel piping. Preventive measures will be in accordance with standard industry practice for maintaining external coatings and wrappings. Buried pipes will be inspected when they are excavated during maintenance.	Prior to entering the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.4
	Cast Austenitic Stainless Steel (CASS) Evaluation Program		
5	The CASS evaluation program will augment the inspection of reactor coolant system components in accordance with the ASME Boiler and Pressure Vessel Code, Section XI. The CASS evaluation program will manage the effects of loss of fracture toughness in reactor coolant system CASS components susceptible to thermal aging embrittlement using additional inspections and a component-specific flaw tolerance evaluation.	Prior to entering the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.5.

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Environmental Qualification of Electrical Components		
6	Entergy will continue to include the entire length of cable from the detector to the control room instrumentation in the EQ program during the period of extended operation even though this is not required by 10 CFR 50.49.	Prior to entering the period of extended operation.	Letter 2CAN010401, Attachment 1, pg 1.
	Fire Water System Program		
7	The Fire Water System Program will be enhanced to inspect a sample of sprinkler heads using the guidance in NFPA 25.	Prior to entering the period of extended operation..	ANO-2 LRA, Appendix A, Section A.2.1.11.

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Heat Exchanger Monitoring Program		
8	The Heat Exchanger Monitoring Program will manage loss of material and cracking, as applicable, on heat exchangers in various systems. The Heat Exchanger Monitoring Program will inspect heat exchangers for degradation using non-destructive examinations, such as eddy-current inspections and visual inspections. If degradation is found, then an evaluation will be performed to determine its effects on the heat exchanger's design functions. The acceptance criterion for the tube eddy current inspections of the heat exchanger monitoring program will be wall-loss less than 60% through-wall. Ferritic stainless steel tubes in the shutdown cooling heat exchanger of the Heat Exchanger Monitoring Program will be monitored, where practical, using appropriate non-destructive examination (NDE) techniques such as eddy current testing with specific NDE processes suitable for ferritic stainless material.	Prior to entering the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.13. Letter 2CAN010401 Attachment 1, pg 2 Letter 2CAN010401 Attachment 1, pg 2
9	Entergy will perform a fatigue evaluation showing the acceptability of the regenerative heat exchangers for the period of extended operation or the regenerative heat exchangers will be replaced.	Prior to the end of the current operating license term.	Letter 2CAN030401 Attachment 1, pg 2
	Non-EQ Insulated Cables and Connections Program		
10	The Non-EQ Insulated Cables and Connections Program will apply to accessible (i.e., able to be approached and viewed easily) insulated cables and connections installed in structures within the scope of license renewal and prone to adverse	During the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.17.

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Periodic Surveillance and Preventive Maintenance		
11	The Periodic Surveillance and Preventive Maintenance (PSPM) Program will manage the effects of aging on flexible hoses through visual examination of external and internal surfaces. This visual examination looks for evidence of cracking and changes in material properties such as loss of flexibility and embrittlement. The flexibility of the hoses will be verified through physical manipulation of the hose concurrent with the visual inspection. The details on inspection criteria and frequency for the flex hoses that are included in the PSPM Program will be determined prior to entering the period of extended operation. It is expected that a visual inspection of the internal and external surfaces will be performed. However, it may be determined that periodic replacement of the hoses is preferable and inspections will not be performed. If evidence of degradation is detected, the hoses will be replaced. These hoses will be inspected at least once every 10 years. The hoses that credit the PSPM Program are in the emergency diesel generator, fuel oil, alternate AC, and nitrogen systems. Alternatively, periodic replacement of the hose may be implemented in lieu of periodic inspection.	Prior to entering the period of extended operation.	Letter 2CAN080401 Attachment 2, pg 3 Letter 2CAN060402 Attachment 2, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Reactor Vessel Internals Cast Austenitic Stainless Steel (CASS) Program		
15	The Reactor Vessel Internals CASS Program will manage aging effects of cast austenitic stainless steel reactor vessel internals components. This program will supplement the reactor vessel internals inspections required by the ASME Section XI Inservice Inspection Program. The program will manage cracking, reduction of fracture toughness, and dimensional changes using inspections of applicable components which will be determined based on the neutron fluence and thermal embrittlement susceptibility of the component. A description of the the Reactor Vessel Internals CASS Program, which includes the inspection plan, will be submitted to the NRC for review and approval.	At least 24 months prior to the period of extended operation	ANO-2 LRA, Appendix A, Section A.2.1.23. Letter 2CAN090402 Attachment 2, pg 7 Letter 2CAN100403, Attachment 2, pg 1
16	ANO-2 will begin inspections under the Reactor Vessel (RV) Internals CASS Program during the 20-year period of extended operation, and the inspections will be performed once during the period. ANO-2 plans to perform the inspections of the RV internals CASS components in the fifth inspection interval. The need for subsequent inspections will be based on the results from this inspection.	During the period of extended operation.	Letter 2CAN050401 Attachment 2, pg 1
17	Engineering Report A2-EP-2002-002-0, Section 3.8.2.B.5, Detection of Aging Effects will be revised to reference enhanced VT-1 only as follows, "The enhanced VT 1 examinations of CASS reactor vessel internal parts will be performed one time during the period of extended operation.	Prior to entering the period of extended operation.	Letter 2CAN050401 Attachment 2, pg 2

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
18	Table 5.2-12, note (a) of the FSAR will be revised to add the following statement: The ANO-2 specimen capsule withdrawal schedule will be revised to withdraw and test a standby capsule to cover the peak fluence expected through the end of the period of extended operation.	Upon Issuance of the renewed licences.	Letter 2CAN010401 Attachment 1, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Reactor Vessel Internals Stainless Steel Plates, Forgings, Welds, and Bolting Program		
19	The Reactor Vessel Internals Stainless Steel Plates, Forgings, Welds, and Bolting Program will manage aging effects of reactor vessel internals plates, forgings, welds, and bolting. This program will supplement the reactor vessel internals inspections required by the ASME Section XI inservice inspection program. This program will manage the effects of crack initiation and growth due to stress corrosion cracking or irradiation assisted stress corrosion cracking, loss of fracture toughness due to neutron irradiation embrittlement, and distortion due to void swelling. This program will provide visual inspections and non-destructive examinations of reactor vessel internals. In the development of this program, Entergy will support reactor vessel internals aging effects research through EPRI, the Materials Reliability Program, and other applicable industry efforts to better characterize the internals aging effects and to provide material property data to generate acceptance standards for inspections. Appropriate examination techniques will be selected based on the results of these industry efforts. A description of this program, which includes the inspection plan, will be submitted to the NRC for review and approval.	At least 24 months prior to the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.24. Letter 2CAN050401 Attachment 2, pg 2 Letter 2CAN090402 Attachment 2, pg 7 Letter 2CAN100403, Attachment 2, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
20	Engineering Report A2-EP-2003-002-0, Section 3.8.1.B 6.b will be revised to include the following statement: "Any indication or relevant condition of degradation will be evaluated in accordance with ASME Code Section XI, IWB-3100 by comparing inservice inspection results with acceptance standards of IWB-3400 and IWB-3500."	Prior to entering the period of extended operation.	Letter 2CAN090402 Attachment 2, pg 2
	Steam Generator Integrity Program		
21	The ANO-2 Steam Generator Integrity Program manages the applicable aging effects for the anti-vibration bars and tube support plates. The program requires visual inspection of the steam generator lower internals (tube support structures and tube bundle). This inspection is completed at least once every five years. This inspection checks for loose parts as well as corrosion and other damage in this region. An integrity assessment is performed after each steam generator inspection which addresses all known degradation mechanisms in the steam generator being evaluated. The ANO-2 Steam Generator Integrity Program will include visual inspection of the steam generator lower internals (tube support structures and tube bundle including the U-bend). This inspection is completed at least once every five years. This inspection checks for loose parts as well as corrosion and other damage in this region. The steam generator upper internals (moisture separators) require a thorough visual inspection once every five years. This inspection examines for mechanical damage, corrosion, or other unusual conditions.	During the period of extended operation.	Letter 2CAN070404 Attachment 2, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Service Water Integrity Program		
22	The Service Water Integrity Program will be enhanced to check for evidence of selective leaching during visual inspections. Specific details on the enhancements to the Service Water Integrity Program for managing loss of material due to selective leaching will be developed prior to the period of extended operation. The enhancements to the program to manage loss of material due to selective leaching will be consistent with NUREG-1801 Aging Management Program XI.M33 which includes hardness testing.	Prior to entering the period of extended operation.	Letter 2CAN070409 Attachment 2, pg 1
	Structures Monitoring - Masonry Wall Program		
23	The Structures Monitoring - Masonry Wall Program will manage cracking of masonry walls within the scope of license renewal. Masonry walls are visually inspected as part of the Structures Monitoring - Masonry Wall Program conducted pursuant to the Maintenance Rule, 10CFR50.65.	During the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.27.

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Structures Monitoring - Structural Monitoring		
24	Wells are no longer available for sampling groundwater. Consequently, in lieu of sampling groundwater to confirm that it remains non-aggressive, concrete exposed to groundwater is included in the Structures Monitoring - Structural Monitoring Program for inspection to confirm the absence of aging effects. Under the Structures Monitoring - Structural Monitoring Program concrete exposed to lake water is periodically inspected. Since lake water chemistry is representative of groundwater chemistry, results of these inspections will be representative of underground concrete exposed to groundwater. In addition, when excavated for maintenance activities, inaccessible concrete exposed to groundwater will be visually inspected under the Structures Monitoring - Structural Monitoring Program.	During the period of extended operation.	Letter 2CAN080401 Attachment 2, pg 1
	System Walkdown Program		
25	The System Walkdown Program will include inspections to manage loss of material, loss of mechanical closure integrity and cracking, as applicable, for systems and components within the scope of license renewal. The program will use general visual inspections of readily accessible system and component surfaces during system walkdowns.	Prior to entering the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.29.
	Wall Thinning Monitoring Program		
26	In lieu of disassembling the expansion joints in the AAC diesel, nondestructive examinations such as ultrasonic testing of the expansion joints will be performed as part of the Wall Thinning Monitoring Program to detect loss of material and cracking.	During the period of extended operation.	Letter 2CAN060402 Attachment 2, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
27	Wall thickness will be the parameter monitored for the Wall Thinning Monitoring Program. The method of detection of aging effects will be non-destructive examinations using industry-accepted methods, such as ultrasonic testing, to determine wall thickness of susceptible components. Inspections will be performed to ensure wall thickness is above the minimum required in order to avoid failures.	During the period of extended operation.	ANO-2 LRA, Appendix A, Section A.2.1.30. Letter 2CAN010401 Attachment 1, pg 2
	Water Chemistry Control - Primary and Secondary Water Chemistry Control Program		
28	The FSAR Supplement for the Primary and Secondary Water Chemistry Program, LRA Section A.2.1.33, will be revised to include a reference to the EPRI reports TR-105714 and TR-102134 used in the development of the program.	Upon issuance of the renewed license	Letter 2CAN050401 Attachment 2, pg 2

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	One-Time Inspection Program		
29	ANO-2 will implement a One-Time Inspection Program for the components subject to aging management review that were included for 10CFR54.4(a)(2) in the following systems. • Auxiliary building heating and ventilation • Auxiliary building sump • Drain collection header • Liquid radwaste management • Post accident sampling • Resin transfer • Regenerative waste • Spent resin The ANO-2 One-Time Inspection Program will be consistent with the program description in NUREG-1801 Vol. 2, XI.M32, One-Time Inspection. Adverse conditions identified during the inspections will be addressed as part of the ANO-2 Corrective Action Program. Corrective actions may include additional inspections, if warranted based on the inspection results.	Prior to entering the period of extended operation.	Letter 2CAN090402 Attachment 2, pg 2

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
30	The following description of the One-Time Inspection Program will be added to the FSAR Supplement as Section A.2.1.34: A.2.1.34 ONE-TIME INSPECTION The One-Time Inspection Program confirms that the aging effects are being adequately managed for components in raw or untreated water. This program will perform destructive or nondestructive inspections on internal surfaces of a sample of components in the following systems. • Auxiliary building heating and ventilation • Auxiliary building sump • Drain collection header • Liquid radwaste management • Post accident sampling • Resin transfer • Regenerative waste • Spent resin The One-Time Inspection Program will be initiated prior to the period of extended operation.	Upon Issuance of renewed license	Letter 2CAN090402 Attachment 2, pg 3

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Concrete Containment Tendon Prestress		
31	Loss of tendon prestress will be managed during the period of extended operation by continued implementation of tendon inspections required by ASME Code Section XI IWL. Relevant operating experience, including experience with prestressing systems described in NRC Information Notice (IN) 99-10, will be considered during inspections and data analysis. Prior to the entering the period of extended operation, trend lines for ANO-2 tendon prestressing forces will be developed using regression analysis in accordance with guidance provided in NRC Information Notice (IN) 99-10. If future tendon examination data diverge from the expected trend, the discrepancy will be addressed in accordance with requirements of the Containment Inservice Inspection (ISI) Program (IWE/IWL) and the current licensing basis. Specifically, if prestressing force trend lines indicate that existing prestressing forces in the containment would go below the minimum required values (MRVs) prior to the next scheduled inspection (Reference 10CFR50.55a(b)(2)(ix)(B) or 10CFR50.55a(b)(2)(viii)(B)), then systematic retensioning of tendons, a reanalysis of the containment or a reanalysis of the post-tensioning system is required to ensure the design adequacy of containment.	Prior to entering the period of extended operation.	Letter 2CAN090402 Attachment 2, pg 4

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
32	The FSAR Supplement for Section A.2.2.4 will be revised as follows: **A.2.2.4 CONCRETE CONTAINMENT TENDON PRESTRESS** The analysis of loss of prestress in the containment building post-tensioning system is a time-limited aging analysis. Loss of tendon prestress in the containment building post-tensioning system will be managed for license renewal in accordance with the Containment ISI Program. This program, discussed in Section A.2.1.14, includes tendon surveillance testing. Prior to the period of extended operation, trend lines for ANO-2 tendon prestressing forces will be developed using regression analysis in accordance with guidance provided in NRC IN 99 10. If prestressing force trend lines indicate that existing prestressing forces in the containment would go below the minimum required values (MRVs) prior to the next scheduled inspection (Reference 10CFR50.55a(b)(2)(ix)(B) or 10CFR 50.55a(b)(2)(viii)(B)), then systematic retensioning of tendons, a reanalysis of the containment or a reanalysis of the post tensioning system is required to ensure the design adequacy of containment.	Upon issuance to the renewed license.	Letter 2CAN090402 Attachment 2, pg 5

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Reactor Coolant Pump Flywheel		
33	The FSAR Supplement for Section A.2.2.6.6 will be revised as follows: The flaw growth analysis associated with the reactor coolant pump motor flywheel is conservatively treated as a time-limited aging analysis. The analysis addresses the growth of pre-existing cracks subjected to 4,000 reactor coolant pump motor startup or shutdown cycles, which exceeds by a factor of eight the number of RCP cycles projected through the period of extended operation. Therefore, the flaw growth analysis remains valid for the period of extended operation.	Upon issuance of the renewed license.	Letter 2CAN090402 Attachment 2, pg 6
	Miscellaneous Systems		
34	The FSAR Supplement will be revised as follows: The Quality Assurance Program implements the requirements of 10CFR50, Appendix B. The Quality Assurance Program includes the elements of corrective action, confirmation process, and administrative controls and is applicable to all aging management programs credited for license renewal including programs for safety-related and non-safety related structures, systems and components.	Upon issuance of the renewed license.	Letter 2CAN050403 Attachment 2, pg 1
35	The intake canal is periodically inspected as part of the ANO Maintenance Rule Program. Periodic inspections will continue during the period of extended operation.	During the period of extended operation.	Letter 2CAN080401 Attachment 2, pg 1

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
36	Periodic maintenance will be used to manage the loss of material in the Starting Air System for the AAC diesel. The use of periodic maintenance will ensure the proper operation of the air dryers such that significant moisture will not be entrained in the portion of the system that is subject to aging management review.	During the period of extended operation.	Letter 2CAN060402 Attachment 2, pg 1
37	Periodic inspections will be used to manage the loss of material in the Starting Air System for the EDGs.	During the period of extended operation.	Letter 2CAN060402 Attachment 2, pg 1
38	For gray cast iron, ANO-2 will manage loss of material due to selective leaching by one of the following programs that include the management of loss of material due to selective leaching. Periodic Surveillance and Preventive Maintenance Service Water Integrity Program Fire Protection Program	During the period of extended operation.	Letter 2CAN030401 Attachment 1, pg 1
	Environmentally-Assisted Fatigue (GSI-190)		
39	Should ANO-2 select the inspection option (Option 4) to manage environmentally-assisted fatigue, details of the scope, qualification, method, and frequency of the inspections will be provided to the NRC for review and approval prior to entering the period of extended operation.	Prior to entering the period of extended operation.	License Renewal Application, pg. 4.3-6

ITEM NUMBER	COMMITMENT	IMPLEMENTATION SCHEDULE	SOURCE
	Non-EQ Inaccessible Medium-Voltage Cables		
40	The ANO-2 "Non-EQ Inaccessible Medium-Voltage Cable Program" will include testing of underground medium-voltage cables exposed to significant voltage that perform a license renewal intended function, regardless of preventive actions to prevent exposure to significant moisture.	Prior to entering the period of extended operation.	Letter 2CAN020502 Attachment 1, pg 1
	Additional Commitments		
41	The chemistry procedure and engineering report will be revised to address loss of the passive layer if chemistry limits are out of specification for an extended period.	Prior to entering the period of extended operation	Letter 2CAN120403 Attachment 1, pg 1
42	The PSPM Program will be revised to include an inspection of the alternate AC diesel generator starting air tank.	Prior to entering the period of extended operation	Letter 2CAN120403 Attachment 1, pg 1

APPENDIX B: CHRONOLOGY

This appendix contains a chronological listing of the routine licensing correspondence between the U.S. Nuclear Regulatory Commission (NRC) staff and the Entergy Operations, Inc. (Entergy), and other correspondence regarding the NRC staff's reviews of the Arkansas Nuclear One, Unit 2 (ANO-2), (under Docket Number 50-368) license renewal application (LRA).

October 14, 2003	In a letter (signed by C. Anderson), Entergy submitted its LRA for the Arkansas Nuclear One, Unit 2. ML032890492
October 21, 2003	In a letter (signed by P. Kuo), NRC informed Entergy of the receipt of the LRA for ANO-2 and Gregory Suber will be the PM for safety review and Thomas Kenyon will be PM for environmental review. ML032940160
November 14, 2003	In a letter (signed by P. Kuo), NRC informed Entergy the LRA was accepted and sufficient for docketing and proposed review schedule and issued notice of opportunity for hearing for the LRA of ANO-2. ML033210028
January 22, 2004	In a letter (signed by T. Mitchell), Entergy provided clarifications related to questions from the staff's aging management audit. ML040300229
February 20, 2004	In a letter (signed by G. Suber), NRC provided Entergy a revised schedule for the conduct of review for ANO-2. ML040550582
February 26, 2004	In a memorandum (signed by G. Suber), NRC summarized the December 15 and 16, 2004 conference calls between the NRC staff and Entergy regarding draft Request for Additional Information (RAI) concerning the staff's review of the LRA. ML040610542
March 8, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML040710466
March 24, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML040710466
March 29, 2004	In a letter (signed by T. Mitchell), Entergy provided clarifications related to questions from the staff's aging management audit. ML040860665
April 6, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041000168
April 13, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041050820
April 14, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041050858

April 19, 2004	In a letter (signed by L. Smith), NRC provided Entergy the Screening and Scoping Inspection Report 05000368/2004-06. ML041100648
April 23, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041200384
May 5, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041280554
May 11, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041330486
May 17, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041380284
May 19, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041420057
May 19, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041420062
May 19, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041420067
May 19, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041420060
May 24, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041480292
May 25, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041470021
May 26, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041480134
June 10, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041670312
June 11, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041620247
June 16, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041700183
June 21, 2004	In a memorandum (signed by G. Suber), NRC summarized the May 20, 2004 conference call between the NRC staff and Entergy regarding draft Request for Additional Information (RAI) concerning the staff's review of the LRA. ML041730571

June 21, 2004	In a memorandum (signed by G. Suber), NRC summarized the March 24 and April 16, 2004 conference calls between the NRC staff and Entergy regarding draft Request for Additional Information (RAI) concerning the staff's review of the LRA. ML041730526
June 21, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041750125
June 21, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041750119
June 23, 2004	In a memorandum (signed by G. Suber), NRC summarized the March 24 and May 27, 2004 conference calls between the NRC staff and Entergy regarding draft Request for Additional Information (RAI) concerning the staff's review of the LRA. ML041770037
June 24, 2004	In a letter (signed by G. Suber), NRC provided ANO-2 requests for additional information concerning its review of the LRA. ML041770557
July 01, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML041880147
July 22, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML042160356
July 22, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML042160349
July 22, 2004	In a letter (signed by T. Mitchell), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML042160860
August 18, 2004	In a letter (signed by D James), Entergy provided clarification responses to NRC concerning RAIs related to the staff's review of the LRA. ML042660110
Sept. 10, 2004	In a letter (signed by D. James), Entergy provided clarification responses to NRC concerning RAIs related to the staff's review of the LRA. ML042390431
Sept. 23, 2004	In a letter (signed by D. James), Entergy provided responses to NRC concerning RAIs related to the staff's review of the LRA. ML042790302
October 13, 2004	In a letter (signed by D. James), Entergy provided an annual update to the LRA. ML043010592
December 13, 2004	In a letter (signed by D. James), Entergy provided comments on the Draft Safety Evaluation Report. ML043560138

February 28, 2004	In a letter (signed by D. James), Entergy provided clarification on responses to RAIs related to the NRC staff's review of the LRA. ML050670491

APPENDIX C: PRINCIPAL CONTRIBUTORS

LICENSE RENEWAL AND ENVIRONMENTAL IMPACTS PROGRAM

Name	RESPONSIBILITY
Pao-Tsin Kuo	Branch Chief
Samson Lee	Section Chief
Gregory Suber	Project Manager
Thelma Davis	Clerical Support
Yvonne Edmonds	Administrative Support
Melissa Jenkins	Administrative Support
Kimberley Corp	Technical Support
Juan Ayala	Technical Support
Tae Kim	Technical Support
Kamishan Martin	Technical Support
Maurice Heath	Technical Support
Frank Akstulewicz	Management Supervision
Hansraj Ashar	Civil Engineering
Jose Calvo	Management Supervision
Terence Chan	Management Supervision
Stephanie Coffin	Management Supervision
Gregory Cranston	Team Leader
Robert Dennig	Management Supervision
Richard Dipert	Fire Protection
James Drake	Regional Inspector
Johnny Eads	Project Manager
Greg Galletti	Quality Assurance
George Georgiev	Materials Engineering
Raj Goel	Safety Assessment
Jin-Sien Guo	Plant Systems
Mark Hartzman	Civil Engineering
Gene Imbro	Management Supervision
Ronaldo Jenkins	Electrical Engineering
John Knox	Electrical Engineering
Carolyn Lauron	Materials Engineering
Arnold Lee	Mechanical Engineering
Andrea Lee	Materials Engineering
Chang Li	Plant Systems
Renee (Yueh-Li) Li	Mechanical Engineering
Tilda Liu	Project Management
Louise Lund	Management Supervision
John Ma	Civil Engineering
Kamal Manoly	Management Supervision
James Medoff	Materials Engineering
Richard McNally	Mechanical Engineering

Matthew McConnell	Electrical Engineering
Rebecca Nease	Inspection Team Leader
Duc Nguyen	Electrical Engineer
Janak Raval	Safety Assessment
Bill Roger	Quality Assurance
David Solorio	Management Supervision
David Terao	Management Supervision
Dale Thatcher	Management Supervision
George Thomas	Reactor Systems
John Tsao	Materials Engineering
Harold Walker	Safety Assessment
Steve West	Management Supervision
Sunil Weerakkody	Management Supervision

CONTRACTORS

Contractor	Technical Area
Kim Green	Mechanical Engineering
Richard Morante	Civil Engineering
Shuiwing Pam	Mechanical Engineering
Steve Pope	Team Leader

APPENDIX D: REFERENCES

This appendix contains a listing of references used in the preparation of the Safety Evaluation Report prepared during the review of the license renewal application for Arkansas Nuclear One, Unit 2, Docket Number 50-368.

American Society of Mechanical Engineers (ASME)

ASME Code, Section III

ASME Code, Section III, Class 1

ASME Code, Section III, Classes 2 and 3

ASME Code, Section III, Subsection NC-3200

ASME Code, Section VIII, Division 1

ASME Code, Section VIII, Division 2

ASME Code, Section VIII, Division 1; AWWA; or MSS

ASME Code, Sections VIII or III, Subsections NC or ND

ASME Code, Section XI

ASME Code, Section XI, Subsection IWL

ASME Code Appendix G to Section XI

ASME Code Case N-481

ASME Code Case N-588

ASME Code Case N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves, Section XI, Division 1,"

ANSI B31.1, Power Piping

American Society for Testing and Materials (ASTM)

ASTM E185-82, "Recommended Practice for Surveillance Tests for Nuclear Reactor Vessels"

ASTM E-185, "Standard Practice for Conducting Surveillance Tests for Light Water Cooled Nuclear Power Vessels"

ASTM standard D 1796, Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure), 2002

ASTM standard D 2709, Standard Test Method for Water and Sediment in Middle Distillate Fuels by Centrifuge, 2001

ASTM standard D 2276, Standard Test Method for Particulate Contaminant in Aviation Fuel by Line Sampling

ASTM Standard D 4057, Standard Practice for Manual Sampling of Petroleum and Petroleum Products, 2000

Code of Federal Regulations (CFR)

10 CFR 50.34a, Design Objectives for Equipment to Control Release of Radioactive Material In Effluents - Nuclear Power Reactors, US Nuclear Regulatory Commission

10 CFR 50.48, Fire Protection, US Nuclear Regulatory Commission

10 CFR 50.49, Environmental Qualification of Electric Equipment to Safety For Nuclear Power Plants, US Nuclear Regulatory Commission

10 CFR 50.55a, Codes and Standards, US Nuclear Regulatory Commission

10 CFR 50.59, Changes, Tests, and Experiments, US Nuclear Regulatory Commission

10 CFR 50.61, Fracture Toughness Requirement For Protection Against Pressurized Thermal Shock Events, US Nuclear Regulatory Commission

10 CFR 50.62, Requirements For Reduction of Risk From Anticipated Transients Without Scram (ATWS) Events For Light-Water-Cooled Nuclear Power Plants, US Nuclear Regulatory Commission

10 CFR 50.63, Loss of All Alternating Current Power, US Nuclear Regulatory Commission

10 CFR 50.67, Accident Source Term, US Nuclear Regulatory Commission

10 CFR 50 Appendix J, Primary Reactor Containment Leakage Testing For Water-Cooled Power Plants, US Nuclear Regulatory Commission

10 CFR 54.21, Contents of Application—Technical Information, US Nuclear Regulatory Commission

10 CFR Part 54, Requirements for Renewal of Operating Licenses for Nuclear Power Plants, US Nuclear Regulatory Commission

10 CFR 54.4, Scope, US Nuclear Regulatory Commission

10 CFR 54.30, Matters Not Subject To A Renewal Review, US Nuclear Regulatory Commission

10 CFR 100.11, Determination of Exclusion Area, Low Population Zone, and Population Center Distance, US Nuclear Regulatory Commission

29 CFR Chapter XVII, 1910.134, Respiratory Protection, US Nuclear Regulatory Commission

29 CFR Chapter XVII, 1926.134, Respiratory Protection, US Nuclear Regulatory Commission

42 CFR Chapter I, Part 84, Approval of Respiratory Protective Devices, US Nuclear Regulatory Commission

Entergy Operations, Inc.

Entergy Letter No. 0CAN070404, Response to NRC 2004-01 Regarding Inspection of Alloy 82/182/600 Materials Used in Pressurizer Penetrations and Steam Space Piping Components (July 27, 2004)

Entergy Letter No. Letter No. 2CAN090402, dated September 10, 2004.

Entergy Letter No. 2CAN090403, dated September 23, 2004

Engineering Report 02-R-2008-01, the Scoping Methods and Results Report

Engineering Report A2-EP-2002-004, "TLAA and Exemption Evaluation"

Engineering Report A2-ME-2003-001-0, Revision 1, Section 3.62, "Plant Heating," and Section 3.87, "Turbine Building Sump,"

Engineering Report A2-ME-2003-001-1, "Aging Management Review of Nonsafety-related Systems and Components Affecting Safety-related Systems"

Electric Power Research Institute (EPRI) and Material Reliability Program (MRP)

EPRI NP-1406-SR, "Nondestructive Examination Acceptance Standards."

EPRI NP-5067, Good Bolting Practices

EPRI NP-5569, Chromate Substitutes for Corrosion Inhibitors in Cooling Systems, December 1987

EPRI NP-5769, Degradation and Failure of Bolting in Nuclear Power Plants, Volumes 1 and 2, May 1988

EPRI TR-105714, PWR Primary Water Chemistry Guidelines: Vol. 1: Revision 4; Vol. 2: Revision 4 Volume 2, January 1999

EPRI TR-102134,Revision 5, PWR Secondary Water Chemistry Guidelines, January 1999

EPRI TR-104213, Bolted Joint Maintenance & Applications Guide, December 1995

EPRI TR-105504, Primer on Maintaining the Integrity of Water-Cooled Generator Stator Windings, October 1995

EPRI TR-107396, Closed Cooling Water Chemistry Guidelines, April 2004

Nuclear Energy Institute (NEI)

NEI 95-10, Industry Guidelines for Implementing the Requirement of 10CFR Part 54 The License Renewal Rule, Revision 3, March 2001

NEI 97-06, Steam Generator Program Guidelines

United States Nuclear Regulatory Commission (NRC)

Bulletins
(IE) Bulletin 79-01B, "Environmental Qualification of Class IE Equipment ," February 8, 1979

NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems," June 22, 1988

NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification," December 20, 1988

NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," August 3, 2001

NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," March 18, 2002

NRC Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs," August 9, 2002

NRC Bulletin 2004-01, "Inspection of Alloy 82/182/600 Materials Used in the Fabrication of Pressurizer Penetrations and Steam Space Piping Connections at Pressurized-Water Reactors," May 28, 2004

Executive Orders
NRC Order EA-03-009, ISSUANCE OF ORDER ESTABLISHING INTERIM INSPECTION REQUIREMENTS FOR REACTOR PRESSURE VESSEL HEADS AT PRESSURIZED WATER REACTORS

Generic Safety Issue
GSI-166, Adequacy of the Fatigue Life of Metal Components

GSI-168, EQ of Electrical Components

GSI-190, Fatigue Evaluation of Metal Components for 60-year Plant Life

Information Notices
NRC Information Notice (IN) 89-33, "Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs,"

NRC Information Notice (IN) 89-65, "Potential For Stress Corrosion Cracking in Steam Generator Tube Plugs Supplied by Babcock and Wilcox," September 8, 1989

NRC Information Notice (IN) 90-04, "Cracking of The Upper Shell-to-transition Cone Girth Welds in Steam Generators," January 26, 1990

NRC Information Notice (IN) 92-20, "Inadequate Local Leak Rate Testing"

NRC Information Notice (IN) 94-87, "Unanticipated Crack in a Particular Heat Of Alloy 600 Used For Westinghouse Mechanical Plugs For Steam Generator Tubes," December 1994

NRC Information Notice (IN) 99-10, "Degradation of Prestressing Tendon Systems in Prestressed Concrete Containment," October 1999

Generic Letters
NRC Generic Letter (GL) 88-05, "Boric Acid Corrosion Of Carbon Steel Reactor Pressure Boundary Component in PWR Plants," March 17, 1988

NRC Generic Letter (GL) 89-13, "Service Water System Problems Affecting Safety-Related Equipment," July 18, 1989

Inspection Reports
NRC 2004-01 Regarding Inspection of Alloy 82/182/600 Materials Used in Pressurizer Penetrations and Steam Space Piping Components (July 27, 2004)

NRC Inspections Guideline 71111.08, "Inservice Inspection Activities."

Miscellaneous
Interim Staff Guidance (ISG)-2, "NRC Staff Position on License Renewal Rule (10 CFR 54.4) As It Relates to the Station Blackout Rule (SBO) (10 CFR 50.63)

SECY-95-245, "Completion of the Fatigue Action Plan," September 25, 1995

Regulatory Information Summary (RIS) 2003-09

ISO 4406, "Hydraulic fluid power -- Fluids -- Method for coding the level of contamination by solid particles," 1999

NUREG-Series Reports
NUREG-0313, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," U.S. Nuclear Regulatory Commission, July 1977, (Rev. 1) July 1980, (Rev. 2) January 1988

NUREG-1743, "Safety Evaluation Report Related to the License Renewal of Arkansas Nuclear One, Unit 1."

NUREG-1766, Section 2.1.3.1, "Safety Evaluation Report Related to the License Renewal of North Anna Power Station, Units 1 and 2, and Surry Power Station, Units 1 and 2," December 2002

NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," April 2001

NUREG-1801, "Generic Aging Lessons Learned (GALL) Report, U.S. Nuclear Regulatory Commission," April 2001

NUREG/CR-6177, "Assessment of Thermal Embrittlement of Cast Stainless Steels,"
"PWR Materials Reliability Project Interim Alloy 600 Safety Assessment for US PWR Plants (MRP-44), Part 1: Alloy 82/182 Pipe Butt Welds,"

NUREG/CR 6717, Section 5.3, "Environmental Effects on Fatigue Crack Initiation in Piping and Pressure Vessel Steels," May 2001.

Regulatory Guides
NRC Regulatory Guide 1.14, Revision 1, Reactor Coolant Pump Flywheel Integrity (August 1975)

NRC Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants

NRC Regulatory Guide 1.190, "Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence (March 2001)"

NRC Regulatory Guide 1.46, "Protection Against Pipe Whip Inside Containment,"

NRC Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials (May 1988),"

<u>**Industry Reports**</u>

Babcock & Wilcox
Babcock & Wilcox report BAW-2241P-A, Revision 1, "Fluence and Uncertainty Methodologies,"

Babcock and Wilcox report BAW-2241P-A, Revision 1, "Fluence and Uncertainty Methodologies," which was published in April 1999.

Babcock and Wilcox Topical Report BAW-2399, Analysis of Capsule W-104, Entergy Operations, Inc., Arkansas Nuclear One Unit 2 Power Plant (September 2001).

Combustion Engineering
CEN-367-A, Revision 000, Leak-Before-Break Evaluation of Primary Coolant Loop Piping in Combustion Engineering Designed Nuclear Steam Supply Systems

CE-NPSD-448, Review of Inhibitors used in Closed Cycle Cooling Water Systems

CE NPSD-1198-P, Revision 00, Low-Alloy Steel Component
Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs

Combustion Engineering Topical Report No. A-NLM-005, dated October 30, 1974

Combustion Engineering Topical Report No. TR-MCD-002, dated March 1976

Westinghouse Topical Reports (WCAP)
WCAP-15973-P, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs,"

APPENDIX E: REQUEST FOR ADDITIONAL INFORMATION

Request for Additional Information (RAI)	Issuance Date	Response Date
Section 1		
Section 2: Structures and Components Subject to Aging Management Review		
Section 2.1 Scoping and Screening Methodology		
RAI 2.1-1 RAI 2.1-2	February 26, 2004	May 19, 2004
RAI 2.1-3 RAI 2.1-4 RAI 2.1-5 RAI 2.1-6 RAI 2.1-7	April 13, 2004	May 19, 2004
Section 2.2 Plant Level Scoping		
RAI 2.2-1	May 11, 2004	June 10, 2004

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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

The safety evaluation report (SER) documents the technical review of the Arkansas Nuclear One, Unit 2 (ANO-2), license renewal application (LRA) by the U.S. Nuclear Regulatory Commission staff (staff). By letter dated October 14, 2003, Entergy Operations, Inc. (Entergy or the applicant), submitted the LRA for ANO-2 in accordance with Title 10 of the Code of Federal Regulations Part 54. Entergy is requesting renewal of the operating license for ANO-2, (Facility Operating License No. NPF-6) for a period of 20 years beyond the current expiration date (midnight, July 17, 2018).

The ANO site is located in southwestern Pope County, Arkansas, on a peninsula formed by Lake Dardanelle. The NRC issued ANO-2 construction permit on December 6, 1972. The operating license was issued by the NRC on September 1, 1978. ANO-2 consists of a Combustion Engineering pressurized water reactor to generate 3026 megawatts-thermal (MWt) or approximately 1023 megawatts-electric (MWe).

This SER presents the staff's review of information submitted to the NRC in the application. The staff's conclusion of its review of the ANO-2 LRA can be found in Section 6 of this SER.

The NRC ANO-2 license renewal project manager is Mr. Gregory F. Suber. Mr. Suber may be reached at 301-415-1124. Written correspondence should be addressed to the Licensee Renewal and Environmental Impacts Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001.

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