June 23, 1999

Mr. William R. McCollum, Jr.
Vice President, Oconee Nuclear Site
Duke Energy Corporation
P. O. Box 1439
Seneca, SC 29679

SUBJECT: OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, LICENSE RENEWAL SAFETY EVALUATION REPORT

Dear Mr. McCollum:

Copies of the subject report were sent to you and the associated distribution list by our letter dated June 16, 1999. We have found that a number of the copies are missing pages 3-173 and 3-185 because of a printing error. As you are aware, the SER was printed on both sides of the page. To make replacement of the missing pages easier, replacement pages for the SER have been enclosed. Specifically, enclosed are new pages 3-173 through 3-186 that should replace existing pages 3-174 through 3-186. We apologize for any inconvenience.

Sincerely,

Original Signed By

Joseph M. Sebrosky, Project Manager
License Renewal and Standardization Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket Nos. 50-269, 50-270, and 50-287

Enclosure: As stated

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3.7 Steam and Power Conversion Systems (SPCSs)

3.7.1 Introduction

Duke (the applicant) described its aging management review (AMR) of the steam and power conversion systems (SPCSs) for license renewal in two separate sections of its license renewal application (LRA): Section 3.5.9, "Steam and Power Conversion Systems," and Section 4.21, "Piping Erosion/Corrosion Program," of Exhibit A of the LRA. The staff reviewed these sections of the application to determine whether the applicant has demonstrated that the effects of aging on the SPCSs will be adequately managed during the period of extended operation as required by 10 CFR 54.21(a)(3). In the course of its review, the staff sent the applicant requests for additional information (RAIs) concerning these systems, and by letter dated December 14, 1998, the applicant responded.

3.7.2 Summary of Technical Information in the Application

Section 3.5.9 of Exhibit A in the LRA describes four SPCSs: main steam system (MSS), condensate system (CS), emergency feedwater system (EFS), and feedwater system (FS).

The MSS transports steam from the steam generators to the main turbine, to the main feedwater pump turbine, and to the emergency feedwater turbine during emergency operation, and to a variety of other components during normal operation. With the exception of orifices, all the components in the MSS are constructed from carbon steel. The orifices are constructed from stainless steel. All the components are exposed to the external environments of the auxiliary, turbine, and reactor buildings and to an internal environment of treated water which could be heated to superheated, dry, saturated, or partially condensed steam.

The CS delivers condensate from condenser hotwells to the suction of the main feedwater pumps, purifies the condensate, removes noncondensable gases, and heats the condensate. It also supplies water to the emergency feedwater pumps during emergency operation. The components in the CS are constructed from carbon steel, stainless steel, cast iron, brass, and copper. They are exposed to the internal environment of treated water with the exception of the channel heads and some tubes and tubesheets in the condensate cooler heat exchangers, which are exposed to raw water. The external environment for all the components is air in the turbine building.

The EFS supplies water to the steam generators in the event of loss of both main feed water pumps. The components in the EFS are constructed from carbon steel, low alloy steel, and stainless steel. They are exposed to an internal environment of treated water and to an external environment of air in the turbine and reactor buildings.

The FS receives its water from the CS. It increases feedwater pressure and temperature, and delivers the feedwater to the steam generators. The components in the FS are constructed from carbon steel and stainless steel. They are exposed to the internal environment of treated water and to an external environment of air in the auxiliary, reactor and the turbine buildings.

3.7.2.1 Effects of Aging

The applicant evaluated the applicability of aging effects for components subject to the AMR. It determined that for the materials of construction of the components in the SPCSs, the aging effects from the following plausible mechanisms should be managed for license renewal: loss of material from general corrosion, galvanic corrosion, pitting, and erosion/corrosion in components made from carbon steel, low alloy steel, brass, and copper; stress-corrosion cracking and pitting of stainless steel components; and selective leaching in the cast iron components.

3.7.2.2 Aging Management Programs

The applicant has identified a number of aging management programs for controlling the effects of the aging effects in the SPCSs. The programs were developed from industry wide data, industry developed methodologies, NRC documents, and the applicant's own experience. The applicant concluded that these programs would manage the aging effects in such a way that the intended function of the components in the SPCSs will be maintained during the period of extended operation, consistent with the current licensing basis (CLB), under all design conditions. The following existing aging management programs were identified by the applicant:

- chemistry control program
- piping erosion/corrosion program
- service water piping corrosion program
- cast iron selective leaching program
- galvanic susceptibility inspection program
- preventive maintenance activity assessment

Erosion/corrosion is the most significant aging mechanism in terms of damage to components in the SPCSs. The piping erosion/corrosion program is considered, therefore, one of the most important programs for managing aging effects. The program applies to the MSS and FS because some of the carbon steel components in the main steam and feedwater systems, included in the AMR, have been identified as being susceptible to erosion/corrosion damage. Section 4.21 of Exhibit A in the LRA contains description of the existing erosion/corrosion program, which the applicant intends to use during the period of extended operation. This program systematically inspects erosion/corrosion-susceptible components for signs of degradation and, if such signs are detected, directs appropriate corrective actions.

The applicant's erosion/corrosion program consists of predicting which components are susceptible to erosion/corrosion. For that purpose the applicant initially used the predictive method recommended by EPRI report NP-3944. More recently, the applicant has used the

EPRI-developed computer code CHECWORKS, although the previous predictive method is still in use for predicting erosion/corrosion in some components. The components found to be affected by erosion/corrosion are inspected either by ultrasonic testing or by radiography. The findings of these inspections are then evaluated against the acceptance criteria, which specify an allowable limit for the minimum thickness of the component. If the code predicts that at the next outage this limit will be exceeded, the component is repaired or replaced. The frequency of inspections depends on location, previous inspection results, calculated material loss, and operating conditions. The applicant has had a formalized erosion/corrosion program since the early 1980s.

3.7.3 Staff Evaluation

In accordance with 10 CFR 54.21(a)(3), the staff reviewed the information included in Sections 3.5.9 and 4.21 of Exhibit A of the LRA. The purpose of the review was to ascertain that the applicant has adequately demonstrated that effects of aging will be adequately managed so that the intended function of the systems will be maintained consistent with the CLB for the period of extended operation. The staff evaluation of the applicant's identification of structures and components subject to an AMR is discussed separately in Section 2.2 of this SER.

3.7.3.1 Effects of Aging

The components in the SPCSs are constructed from carbon, low-alloy and stainless steel, cast iron, copper, and brass. They are exposed to an external environment of air in the auxiliary, turbine, and reactor buildings, which by itself will not cause any significant aging effects. Internally, the components in the SPCSs are exposed to a treated water/steam environment with the exception of the secondary side of the main condensers and condensate coolers in the CS, which remain in contact with raw water. In the systems carrying raw water, the aging effects are loss of material from general corrosion of carbon steel components and pitting and stress-corrosion cracking of stainless steel components. The following material degradation effects were identified in the systems carrying treated water and steam: loss of material from general corrosion and pitting of carbon steel, low-alloy steel, cast iron, brass, and copper; loss of material from erosion/ corrosion of carbon steel components; galvanic corrosion of coupled materials having different electrochemical potentials; selective leaching of cast iron and loss of material from pitting; and stress-corrosion cracking of stainless steel components.

The only potential aging effect not related to corrosion is damage from mechanical vibration of piping systems and supports. However, in response to the staff's inquiry (RAI 3.5.9-4), the applicant has stated that this damage could only be attributed to poor design and typically will occur over a relatively short period of time before being detected and corrected to prevent recurrence. The staff concurs with the applicant's assessment and conclusion that mechanical vibration is not an applicable aging effect for the piping systems in the SPCSs.

The applicant supplied references to ONS-specific as well as industry-wide experience to supports its identification of applicable aging effects for steam and water conversion systems.

Aging Management Review

The staff concludes that, on the basis of the description of the internal and external environments and material of fabrication for these systems, the applicant has included aging effects that are consistent with published literature and industry experience and, thus, are acceptable to the staff.

3.7.3.2 Aging Management Program for License Renewal

The staff evaluated the applicant's aging management programs in order to determine if they contain the essential elements needed to provide adequate aging management of the components in the SPCSs so that the components will perform their intended functions in accordance with the CLB during the period of extended operation. In its LRA the applicant stated that the activities for license renewal will be conducted in accordance with programs meeting the requirements of 10 CFR Part 50, Appendix B, and cover all structures and components subject to an AMR. Presented below are the results of the staff's evaluation of the applicant's programs for monitoring and controlling aging effects on the SPCSs.

The applicant is using several programs to manage aging effects in various systems of the SPCSs. The staff has evaluated the following programs in the sections of the SER listed below:

- Section 3.2.2, "Chemistry Control Program"
- Section 3.2.8, "Cast Iron Selective Leaching Inspection"
- Section 3.2.9, "Galvanic Susceptibility Inspection"
- Section 3.2.10, "Preventive Maintenance Activity Assessment"
- Section 3.2.13, "Service Water Piping Corrosion Program"

Piping Erosion/Corrosion Program

The staff evaluation of the Duke aging management programs focused on the program elements rather than details of specific plant procedures. The staff evaluated how effectively the piping erosion/corrosion program incorporates the following 10 elements: (1) scope of program, (2) preventive actions, (3) parameters monitored or inspected, (4) detection of aging effects, (5) monitoring and trending, (6) acceptance criteria, (7) corrective actions, (8) confirmation process, (9) administrative control, and (10) operating experience.

The application states that corrective actions, the confirmation process, and administrative controls for license renewal are in accordance with the site-controlled quality assurance program pursuant to 10 CFR Part 50, Appendix B, and cover all structures and components subjected to an AMR. The staff's evaluation of the applicant's quality assurance program is presented separately in Section 3.2.3 of this SER and is not discussed further in this section.

Erosion/Corrosion can be mitigated to some degree by controlling water chemistry which is achieved by the Chemistry Control Program *(Preventive Action)*. The other method for controlling the damaging effects of erosion/corrosion is timely detection and appropriate corrective actions. The applicant's piping erosion/corrosion program uses this other method.

The staff reviewed the information in LRA Section 4.21, "Piping Erosion/Corrosion Program." The activities in this program are characterized by several attributes which the staff has evaluated to determine if they adequately manage the aging effects during the period of extended operation. In general, the program follows the guidelines and recommendations of EPRI document NSAC-202L, Revision 1, concerning prediction, inspection, and repair and replacement of components damaged by erosion/corrosion. The applicant included in its piping erosion/corrosion program the following components of the MSS and FS: the emergency feedwater pump turbine casing, piping, tubing, and valve bodies in the MSS, and the emergency feedwater header, main feedwater header, piping, and valve bodies in the FS. The staff finds that they represent the components susceptible to erosion/corrosion in the portion of the plant included in the LRA (*Scope of Program*). The computer code CHECWORKS, used by the applicant, predicts the components which may be damaged by erosion/corrosion and need to be inspected. It is an industry-wide, well-established code which is being continually revised and improved (*Parameters Monitored or Inspected*). Using this program, the applicant will be able to evaluate the rate at which component wall thinning by erosion/corrosion is occurring (*Monitoring and Trending*). Wall thickness is measured by ultrasonic testing or by radiography which are standard, well-developed techniques producing reliable results (*Detection of Aging Effects*). The criterion for component replacement is based on allowable minimum wall thickness determined by the component design code of record. The requirements of this code for bending and/or torsional stresses in the pipe from other loadings and pressure design (hoop stress) are included in the review. These other loadings are defined by the ONS design and include, but are not limited to, stresses from the dead weight of the piping system, thermal expansion, earthquake loadings, and dynamic fluid transients. Using these methods and applying this replacement criterion, the applicant will be able to successfully manage all the plausible aging effects caused by erosion/corrosion (*Acceptance Criteria*) . The program has been successful in managing loss of material from erosion/corrosion, and since its inception no steam leaks have occurred in the portions of the systems within the scope of license renewal. Only one section of piping associated with the feedwater bypass control valve discharge has required replacement and no component replacement has been necessary in the main steam system (*Operating Experience*). The staff finds the applicant's piping erosion/corrosion Program acceptable.

<u>Main Steam System</u>

The methods used by the applicant for managing aging effects on the components in the MSS consist of monitoring and controlling the aging effect directly or the conditions which contribute to the onset and propagation of a specific aging effect. The applicant has two programs applicable to managing aging effects: the chemistry control program and the piping erosion/corrosion program. The function of the chemistry control program is to control the conditions leading to different types of corrosion, including erosion/corrosion. The applicant's chemistry control program is evaluated in Section 3.2.2 of this SER. In addition, the applicant's piping erosion/corrosion program directly monitors aging effects from erosion/corrosion and specifies corrective actions to be taken in case damage is detected. This program is applicable to the MSS because this system contains carbon steel components susceptible to erosion/corrosion.

By using the chemistry control program and the piping erosion/corrosion program, the applicant will ensure that all the aging effects will be properly managed and that the MSS will perform its intended functions in accordance with the CLB during the period of extended operation.

Condensate System

The method used by the applicant for managing aging effects from loss of material from carbon steel components exposed to treated water in the CS consists of monitoring and controlling water chemistry through the chemistry control program. For the components in the secondary side of the main condensers and condensate coolers in the CS, which are exposed to raw water, the aging effects will be managed by the service water piping corrosion program which is evaluated in Section 3.2.13 of this SER. The aging effects of the stainless steel tubes exposed to raw water in the main condensers of the CS are managed by the applicant through the preventive maintenance activity assessment program evaluated in Section 3.2.10 of this SER. The aging effects of material loss by selective leaching from the cast iron components are managed by the cast iron selective leaching program evaluated in Section 3.2.8 of this SER. The raw water environment is also responsible for a loss of material from carbon steel components when coupled with other more noble metals. The applicant will manage this aging effect by the galvanic susceptibility inspection program evaluated in Section 3.2.9 of this SER. The staff concludes that application of the chemistry control, service water piping corrosion, cast iron selective leaching, galvanic susceptibility inspection, and preventive maintenance activity assessment programs will allow the applicant to properly manage the aging effects and ensure that the CS will perform its intended functions during the period of extended operation.

Emergency Feedwater System

The EFS system has components made from stainless, low-alloy, and carbon steel. These components may be susceptible to corrosion when exposed internally to water without proper water chemistry control. The applicant will manage any resulting aging effects by directly monitoring and controlling water chemistry following the guidance specified in the chemistry control program evaluated in Section 3.2.2 of this SER.

Feedwater System

Internally, the components in the FS system are exposed to treated water, which operates at a temperature sufficiently high to make the erosion/corrosion mechanism a plausible aging effect. The applicant's aging management methodology is based, therefore, on two programs: the chemistry control program, evaluated in Section 3.2.2 of this SER, for controlling the conditions which could lead to the onset and propagation of the aging effects in both carbon and stainless steel components, and the piping erosion/corrosion program which provides means for predicting which of the carbon steel components are susceptible to erosion/corrosion and specifies how the inspection of these components is to be performed and what corrective action should be taken. Application of these two programs will ensure that all the relevant aging effects will be properly managed and that the FS will adequately perform its intended functions in accordance with the CLB during the period of extended operation.

3.7.4 Conclusions

The staff has reviewed the information in Section 3.5.9, "Steam and Power Conversion System," and Section 4.21, "Piping Erosion/Corrosion Program," of Exhibit A of the LRA and additional information provided by the applicant in response to the staff RAIs. On the basis of this review, the staff concludes that the applicant has demonstrated that aging effects associated with the subject systems will be adequately managed so that there is a reasonable assurance that the subject systems will perform their intended functions in accordance with the CLB during the period of extended operation.

3.8 Structures and Component Supports

3.8.1 Introduction

Duke Energy Corporation (Duke or the applicant) described its aging management review (AMR) of the structures and component supports (SCSs) in the following sections of Appendix A to its license renewal application (Ref. 1, LRA): Section 3.7, "Aging Effects for Structural Components (SC)"; Section 3.4.11, "Class 1 Components Supports (CS);" Section 4.3.6, "Once Through Steam Generator Upper Lateral Support Inspection"; Section 4.4, "Battery Rack Inspections"; Section 4.11, "Crane Inspection Program"; Section 4.12, "Duke Power Five Year Underwater Inspection of Hydroelectric Dams and Appurtenances"; Section 4.14, "Elevated Water Storage Tank Civil Inspection"; Section 4.15, "Federal Energy Regulatory Commission (FERC) Five Year Inspection"; Section 4.20, "Penstock Inspection"; Section 4.28, "Tendon-Secondary Shield Wall — Surveillance Program;" and Section 4.29, "230 KV Keowee Transmission Line Inspection." The staff reviewed these sections of the application to determine whether the licensee provided adequate information to meet the requirements of 10 CFR 54.21(a)(3) for managing the aging effects of the SCSs for license renewal.

3.8.2 Summary of Technical Information in Application

3.8.2.1 Structures and Components Subject to an Aging Management Review

Section 2.7 of Exhibit A of the LRA contains the information required to identify the ONS structural components that are subject to an AMR for license renewal pursuant to 10 CFR 54.21(a)(1) and (a)(2). Section 2.7.1 of Exhibit A of the LRA provides a description of the process used to identify structural components subject to an AMR. Section 2.7.2 of Exhibit A of the LRA identifies the generic list of structural components that have been determined by the applicant to require an AMR. The list of ONS structures that have been determined to be subject to an AMR follows:

- Auxiliary building, which includes hot machine shop, spent fuel pools for Units 1 & 2 (shared), and Unit 3
- Earthen embankments, including the intake canal dike, Keowee River dam, and Little River dam and dikes
- The intake structure
- Keowee structures, which include the breaker vault, intake structure, penstock, powerhouse, service bay structure, and spillway
- The reactor building's internal structure and unit vent stacks
- The standby shutdown facility
- Turbine buildings, which include switchgear enclosures for Units 1 & 2 (shared) and Unit 3
- Yard structures, which include all areas and components outside the other buildings (specifically, the 230 KV Keowee transmission line towers)
- 230 KV switchyard structures and relay house
- Trenches
- The elevated water storage tank
- Keowee's transformer yard
- ONS's transformer yard

The functions of the structures were determined from a review of information contained in the ONS UFSAR and other related documentation. In order to facilitate aging management review, the applicant classified the above listed structures and structural components into four categories, as follows:

- Concrete structural components
- Steel structural components in an air environment
- Steel structural components in a fluid environment
- Fire barriers

Sections 2.7.2.1 and 2.7.2.2 of Exhibit A of the LRA list individual items included in each of the above four component categories. Sections 2.7.3 through 2.7.10 of Exhibit A of the LRA provide descriptions of each of the eight structural groups listed above that are subject to an AMR.

Class 1 component supports are identified in Section 2.4.11 of the application. Class 1 component supports subject to an AMR are:

- RCS Class 1 piping supports
- Pressurizer supports
- The reactor vessel support skirt
- The control rod drive service structure

The aging effects for anchorage and embedments associated with these supports are addressed in Section 3.7.7 of the application. The approach for identifying the applicable aging effects on Class 1 component supports is described in Section 3.4.1.

3.8.2.2 Effects of Aging

3.8.2.2.1 Applicable Aging Effects for Concrete Structural Components

Section 3.7.2.1 of Exhibit A of the LRA discusses the considerations and basis adopted by Duke in identifying applicable aging effects for concrete structural components.

Duke determined the applicable aging effects that could result in loss of function of concrete structural components to be the following:

- Loss of material from concrete structural components from abrasion and freeze-thaw at the ONS intake structure and the Keowee intake structure, penstock, and spillway
- Cracking of equipment pads from fatigue
- Cracking of unreinforced masonry block and brick walls
- Change in material properties from leaching at the Keowee intake structure, penstock, spillway, and powerhouse

3.8.2.2.2 Applicable Aging Effects for Steel Structural Components in an Air Environment

Section 3.7.2.2 of Exhibit A of the LRA discusses the considerations and basis adopted by Duke in identifying applicable aging effects for steel structural components in an air environment.

Duke reviewed the concrete structural components with respect to the six elements of the aging effects considerations discussed in Section 3.7.2.2 of Exhibit A of the LRA and identified the following aging effects to be applicable to steel structural components in an air environment:

- Loss of material from corrosion when the component is not coated
- Cracking from stress corrosion of high-strength bolting used in the SG support skirt and reactor vessel support skirt

3.8.2.2.3 Applicable Aging Effects for Steel Components in a Fluid Environment

Section 3.7.2.3 of Exhibit A of the LRA discusses the considerations and basis adopted by Duke in identifying applicable aging effects for steel components in a fluid environment.

Duke reviewed the steel components in a fluid environment with respect to the six considerations discussed in Section 3.7.2.3 of Exhibit A of the LRA and identified the following aging effects to be applicable to steel components in a fluid environment:

- Loss of material for uncoated carbon steel in a raw water environment
- Loss of material for stainless steel in a borated water environment
- Cracking of stainless steel in a borated water environment

3.8.2.2.4 Applicable Aging Effects for Fire Barriers

Section 3.7.2.4 of Exhibit A of the LRA discusses the considerations and basis for identifying applicable aging effects for fire barriers. Duke determined that cracking and separation are the applicable aging effects that could result in loss of function of the ONS fire barrier penetration seals.

3.8.2.2.5 Auxiliary Building

The identification of applicable aging effects for concrete components is described in Section 3.7.2.1 of Exhibit A of the LRA. Duke evaluated aging effects for auxiliary building structural components subject to an AMR. Duke determined that the aging effects from the following should be managed for license renewal:

- Cracking of equipment pads, masonry block, and walls
- Loss of material from structural steel beams, columns, plates, trusses, anchorages/embedments, battery racks, and cable tray/conduit and equipment supports
- Loss of material and cracking of spent fuel pool liner, spent fuel rack, and structural steel
- Loss of material or cracking of fire doors/walls and fire barrier penetration seals

3.8.2.2.6 Earthen Embankments

Duke evaluated aging effects for the earthen embankments subject to an AMR. Duke determined that the aging effects from the following should be managed for license renewal:

- Loss of material due to erosion
- Cracking due to settlement

3.8.2.2.7 Intake Structure

Duke evaluated aging effects for those components of the intake structure subject to an AMR that are identified in Section 2.2.3.2.3 of this SER. Duke determined that loss of material is the applicable aging effect for intake structure components, and that it should be managed for license renewal. Intake structure components affected by loss of material are:

- Reinforced concrete beams, columns, floor slabs, and walls
- Anchorages/embedments
- Cable tray and conduit supports
- Trash racks

- Screens
- Checkered plates
- Equipment component supports
- Structural steel beams
- Columns
- Plates
- Trusses
- Pipe supports
- Expansion anchors and instrument racks and frames

Staff evaluation of intake structure components is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.8 Keowee Structures

Duke evaluated aging effects for the Keowee structures subject to an AMR. Duke determined that the following applicable aging effects for the intake structure should be managed for license renewal:

- Cracking of equipment pads, masonry block, and walls
- Loss of material of penstock, intake, spillway, reinforced concrete beams, columns, floor slabs, roof slabs and walls, anchorages/embedments, battery racks, cable tray and conduit supports, checkered plates, equipment component supports, expansion anchors, specialty doors, instrument line supports, instrument racks and frames, pipe supports, stairs, platforms and grating supports, structural steel beams, columns, and plates and trusses
- Change in material properties of penstock; intake; spillway; and reinforced concrete beams, columns, floor slabs, roof slabs, and walls

Staff evaluation of Keowee structures components is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.9 The Reactor Building's Internal Structural Components and Unit Vent Stacks

Duke evaluated aging effects for the reactor building's internal structural components subject to an AMR. Duke determined that the following applicable aging effects for reactor building internal structural components should be managed for license renewal:

- Cracking of equipment pads, masonry block, and walls
- Loss of material of anchorages/embedments; cable trays and conduits; cable tray and conduit supports; checkered plates; crane rails and girders; equipment component supports; expansion anchors; specialty doors (e.g., flood or pressure); instrument line supports; instrument racks and frames; lead shielding supports; pipe supports; stair,

platform, and grating supports; structural steel beams, columns, plates, and trusses; sump screens; unit vent stack; and fuel transfer canal liner plates
- Cracking of anchorage for the OTSG and the reactor vessel support

Staff evaluation of the reactor building's internal structural components and unit vent stacks are discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.10 The Post-Tensioning System

Duke evaluated aging effects for the tendon wire and tendon anchorage portions of the post-tensioning system subject to an AMR. Duke determined the loss of material and cracking of the post-tensioning system are the applicable aging effects for the post-tensioning system that should be managed. Staff evaluation of the post-tensioning system is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.11 The Standby Shutdown Facility

Duke evaluated aging effects for portions of the SSF subject to an AMR that are discussed in Section 2.2.3.6.6 of this SER. Duke determined that the following applicable aging effects for the SSF should be managed for license renewal:

- Cracking of equipment pads and reinforced concrete beams, columns, floor slabs, roof slabs, and walls
- Loss of material of anchorages/embedments; battery racks; cable tray and conduit supports; checkered plates; crane rails and girders; equipment component supports; expansion anchors specialty doors (e.g.; flood or pressure) HVAC duct supports; instrument line supports; instrument racks and frames; pipe supports; stair, platform, and grating supports

Staff evaluation of SSF components is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.12 The Turbine Building

Duke evaluated aging effects for the portions of the turbine building subject to an AMR that are discussed in Section 2.2.3.6.7 of this SER. Duke determined that the aging effects should be managed for license renewal include the following:

- Cracking of equipment pads, masonry block walls, brick walls, and fire walls
- Loss of material of anchorages/embedments; cable tray and conduit supports; checkered plates; crane rails and girders; equipment component supports; expansion anchors; specialty doors (e.g.; flood or pressure); instrument line supports; instrument

racks and frames; pipe supports; stair, platform, and grating supports; structural steel beams, columns, plates, and trusses; and fire doors
- Cracking and separation of fire walls and fire barrier penetration seals.

Staff evaluation of turbine building components is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.13 Yard Structures

Duke evaluated aging effects for yard structures and structural components subject to an AMR. Duke determined that the following aging effects should be managed for license renewal:

- Cracking of equipment pads, masonry block walls, and brick walls
- Loss of material of anchorages/embedments; 230 KV switchyard battery racks in the relay house; cable tray and conduit supports; checkered plates; elevated water storage tanks; equipment component supports; expansion anchors; pipe supports; structural steel beams, columns, plates, and trusses; and transmission towers.

Staff evaluation of the yard structures components is discussed in Sections 3.8.3.1.1 through 3.8.3.1.4 of this SER.

3.8.2.2.14 Class 1 Component Supports

Duke evaluated aging effects applicable to the Class 1 component supports. As a part of its evaluation of applicable aging effects to the Class 1 component supports, Duke also reviewed pertinent industry information, NRC generic communications, and ONS operating experience. The applicable aging effects for Class 1 component supports identified by the applicant in Section 3.4.11 of Exhibit A of the LRA are:

- loss of material by corrosion or boric acid wastage
- change in material properties of Lubrite pads in the OTSG upper lateral support structure

3.8.2.3 Aging Management Programs

3.8.2.3.1 AMP for Auxiliary Building

Duke identified the following as the AMPs for the auxiliary building for license renewal:

- An inspection program for civil engineering structures and components
- Battery rack inspections (for the battery racks)
- A crane inspection program (for the crane rails and girders)
- ONS ISI plan, Examination Category F-A (for Class 1, 2, and 3 piping and equipment component supports)

- An inspection program for civil engineering structures and components (for other steel components)
- A chemistry control program
- A fire protection program.

Duke concluded that these programs would manage the aging effects identified for the auxiliary building in such a way that the functions of the auxiliary building would be maintained consistent with the CLB during the period of extended operation (refer to Table 3.7-1 of the LRA).

3.8.2.3.2 AMP for Earthen Embankments

Duke identified the Federal Energy Regulatory Commission (FERC) 5-year inspection as the AMP for the earthen embankments for license renewal. Duke concluded that the FERC-required 5-year inspection program would manage the aging effects identified for the earthen embankments in such a way that the function of the earthen structures would be maintained consistent with the CLB during the period of extended operation.

3.8.2.3.3 AMP for Intake Structures

For the aging management of the intake structure and its components, the applicant relies on the inspection program for civil engineering structures and components as the program for managing the aging effects. The staff evaluation of the program is described in Section 3.2.6 of this SER. For pipe supports, ISI plan, examination category F-A has been identified as an additional AMP. The staff evaluation of this plan is described in Section 3.2.5 of this SER.

3.8.2.3.4 AMP for Keowee Structures

For the aging management of the Keowee structures and their components, the applicant relies on the following programs:

- A 5-year underwater inspection of hydroelectric dams and appurtenances
- A FERC-mandated 5-year inspection
- An inspection program for civil engineering structures and components
- A penstock inspection
- Battery rack inspections (for the battery racks)
- A crane inspection program (for the crane rails and girders)
- An ONS ISI plan, examination category F-A (piping supports)

The staff evaluation of the inspection program for civil engineering structures and components is described in Section 3.2.6 of this SER. For pipe supports, the ISI plan, examination category F-A, has been identified as an additional AMP. The staff evaluation of this plan is described in Section 3.2.5 of this SER. The staff evaluation of battery rack inspections (for the battery racks)

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