July 9, 1996

NOTE TO: Doris J. Hoover
Document Liaison Officer

FROM: Linda Luther
Licensing Assistant
License Renewal Project
Directorate, DRPM, NRR

SUBJECT: DOCUMENT FOR THE PDR - CALVERT CLIFFS NUCLEAR POWER PLANT, DOCKET NOS. 50-317 and 50-318

I am attaching a handout on "BGE's Deliverables to NRC" dated July 3, 1996, for the Calvert Cliffs Nuclear Power Plant. Please ensure that this document is sent to the Public Document Room under Docket Nos. 50-317 and 50-318.

Attachment: As stated

cc: S. Newberry
S. Flanders

100173

DF03

BGE Deliverables to NRC Enclosed

July 3, 1996

1. Draft Template of a License Renewal Technical Report, with Phase 2 comments incorporated from June 20, 1996 NRC meeting.

2. Feedwater System License Renewal Technical Report, written for LR Technical Report development, for Phase 1 only.

3. Structures License Renewal Technical Report, written for LR Technical Report development, for Phase 1 only.

4. BGE Position on open issue from June 20, 1996 NRC meeting regarding including codes and standards information in LR technical reports.

5. BGE Position on open issue from June 13, 1996 NRC meeting regarding lists of structures and components subject to aging management review.

- DRAFT -

Template of a License Renewal Technical Report

The Technical Report contains two main sections: Scoping and Aging Management. Contents of each are provided below.

I. Scoping

A. System/Structure/Component description

- Provide a general description of the system's purpose and major equipment, including, where appropriate, reference to UFSAR sections.
- Include the conceptual boundaries from the System level scoping results.
- If this is a non system LRA, then a discussion of the make-up of the commodity group should be provided with reference to or incorporation of details from the methodology.
- The information provided herein should be of sufficient detail to allow a reader who is unfamiliar with CCNPP specifics to gain an understanding of the system.

B. Scoped SCs and their intended functions

- Briefly discuss the portion of the system subject to an AMR. Sufficient information should be provided such that a reader who is unfamiliar with CCNPP specifics can gain an appreciation for what is in scope and why. Important here is the relation of the SC to the function that caused the SC to require an AMR.
- Include a simplified system/structure diagram, or reference a drawing in the UFSAR, if that would be helpful.
- Provide a discussion of any SCs within the conceptual boundaries that are covered by a separate AMR/commodity report.
- A listing or table should detail which SCs (or SCs groups) require an AMR.
- Detail here can be limited by referencing the methodology scoping sections.
- List passive intended functions of SCs subject to an AMR. Briefly discuss which passive functions are covered by another AMR or commodity report.
- Any unique grouping or unique major equipment for the LRA should be included here, if appropriate. (The listing of SCs requiring an AMR given above will generally reflect the organization of the rest of the LRA. The purpose of this step is to explain differences between that list and the remaining LRA sections, if any.)

II. Aging Management

A. Introduce and include a table indicating all Age-Related-Degradation-Mechanisms (ARDMs) considered (potential ARDMs) and those determined to result in plausible aging effects.

- DRAFT -

Template of a License Renewal Technical Report

B. The following demonstration (items 1 through 6 below) must be provided for each component type (or group of similar component types) subject to AMR. The arrangement of the information will depend on the results of the AMR, combining components for efficiency based on common materials, environment, aging mechanisms, methods to manage aging, or programs to manage aging, while ensuring that the flow of demonstration logic is still clear:

1. SC materials and environment

- Provide details of the SC materials of construction that are pertinent to the plausible aging issues/passive intended functions.
- Provide a description of the environment(s) to which the SC is subjected, and identify the pertinent environmental parameters related to the aging effects decisions (i.e., plausible and non-plausible determinations). (This might include standby system stagnant conditions.)

Note: In item #2 below the guidance calls for discussing non-plausible ARDMs, based on their "visibility." There may be groups of SCs where multiple non-plausible ARDMs are to be discussed, where, for efficiency, the discussion could be inserted here once, as opposed to repetitive discussions.

2. Plausible aging mechanisms and their effects on SC functions

Describe the aging issues that were considered, including:

- Plausible ARDMs, non-plausible ARDMs (as determined to be required based on "visibility" of issue), and relevant Generic Safety Issue (GSI)/Unresolved Safety Issue (USI) related aging issues.
- Include in the discussion the basis for plausibility/non-plausibility determinations. References to source material should be made, as appropriate.
- Discuss the resultant aging effects of plausible ARDMs. For instance, for piping these are things like cracks in piping, loss of material, loss of mechanical closure integrity of bolted connections.
- Describe how the ARDM(s) affect the SC(s). How do the mechanisms progress? How do they reveal themselves? What do they look like?
- How/to what extent is the passive intended function affected under all CLB conditions?

------------------------------------ *phase 1 above/phase 2 below* ------------------------------------

Template of a License Renewal Technical Report

3. Methods[1] to manage the ARDMs/effects of the ARDMs

Mitigation of the ARDM(s)

- Include **methods** discussed in the Aging Management Review (AMR) Report to mitigate the onset and/or propagation of degradation.
    - Refer back to the characteristics of the applicable ARDM(s) when describing these methods.
    - Discuss what conditions would be maintained? These could be controlled conditions (coatings/painting, ph of internal fluid, etc.) or design conditions that go beyond basic design (like oil-impregnated sand under a fuel oil tank, for instance).

Discovery of the effect(s) of the ARDM(s)

- Include **methods** discussed in the Aging Management Review (AMR) Report to discover the onset and/or propagation of degradation, such as inspecting, monitoring, testing, etc.
    - Refer back to the characteristics of the applicable ARDM(s) when describing these methods.
    - Discuss what conditions would be monitored/inspected. These methods must detect the aging effect over a time period in which there is reasonable assurance that detection will occur prior to the loss of the intended function under all CLB conditions.

4. Identification and description of aging management programs (AMPs)

Mitigation of the ARDM(s)

- Provide information on **existing** plant program(s) which have the SC group within their scope, and which provide mitigation for the SC group/ARDM(s) combination.
    - Include the name of the program.
    - Review the program purpose, scope, bases, developmental standards, references and procedural steps, then provide information that implements the methods discussed in D.
    - Provide the elements of the program that implement the methods identified in D. The elements involve the technology applied to carry out the program,

[1] Section 6.3 of the CCNPP IPA Methodology, "Methods to Manage the Effects of Aging," has guidance.

which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc. again ***only*** as they implement the methods discussed in D.

- Discuss acceptance criteria to ensure timely corrective actions. This should also include a confirmation process to ensure the corrective actions are effective.
- If applicable[3], discuss how the program is periodically verified such that there is reasonable assurance that the program will continue to mitigate the aging effect.
- Briefly discuss relevant CCNPP operating experience with this program.

- For existing plant programs that must be **modified**,

  - Provide the information from above for the existing portion.
  - Describe the aspects that must be modified and how they will affect the program purpose, scope, bases, developmental standards, references or procedural steps.
  - Describe new elements added to carry out the program. The elements involve the technology applied to carry out the program, which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc.
  - Describe how the modified portions implement the methods discussed in D.
  - If applicable[3], discuss how the program is periodically verified such that there is reasonable assurance that the program will continue to mitigate the aging effect.
  - Briefly discuss relevant CCNPP (or industry, if applicable) operating experience with this program.

- For **new** programs,

  - Describe the new program purpose, scope, bases, developmental standards, and references.
  - Describe the new elements for carrying out the program. The elements involve the technology applied to carry out the program, which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc.
  - Describe this information in sufficient detail to demonstrate that the new program implements the methods discussed in D.

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[2] Details of the frequency and criteria can be referenced.

[3] Typically, the aging management programs involve both mitigation and discovery, in which case the discovery activity will serve to satisfy the verification of the mitigation activity.

- If applicable,[3] discuss how the program will be periodically verified such that there is reasonable assurance that the program will continue to mitigate the aging effect.

Discovery of the effects of the ARDM(s)

- Provide information on **existing** plant program(s) which have the SC group within their scope, and which provide discovery for the SC group/ARDM(s) combination.

    - Include the name of the program.
    - Review the program purpose, scope, bases, developmental standards, references and procedural steps, then provide information that implements the methods discussed in D.
    - Provide the elements of the program that match the methods identified in D. The elements involve the technology applied to carry out the program, which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc. again ***only*** as they implement the methods discussed in D.
    - Discuss acceptance criteria to ensure timely corrective actions. This should also include a confirmation process to ensure the corrective actions are effective.
    - If applicable, discuss how the program is periodically verified such that there is reasonable assurance that the program will continue to discover the aging effect.
    - Briefly discuss relevant CCNPP operating experience with this program.

- For existing plant programs that must be **modified**,

    - Provide the information from above for the existing portion.
    - Describe the aspects that must be modified and how they will affect the program purpose, scope, bases, developmental standards, references or procedural steps.
    - Describe new elements added to carry out the program. The elements involve the technology applied to carry out the program, which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc.
    - Describe how the modified portions implement the methods discussed in D.

[3] Typically, when the aging management programs involve both mitigation and discovery, the discovery activity will serve to satisfy the verification of the mitigation activity.
[2] Details of the frequency and criteria can be referenced.

- If applicable, discuss how the program is periodically verified such that there is reasonable assurance that the program will continue to discover the aging effect.
- Briefly discuss relevant CCNPP (or industry, if applicable) operating experience with this program.

- For **new** programs,

  - Describe the new program purpose, scope, bases, developmental standards, and references.
  - Describe the new elements for carrying out the program. The elements involve the technology applied to carry out the program, which could include the frequency and the criteria for establishing the frequency[2] of performance, sample size or location, parameters measured, etc.
  - Describe this information in sufficient detail to demonstrate that the new program implements the methods discussed in D.
  - If applicable, discuss how the program will be periodically verified such that there is reasonable assurance that the program will continue to discover the aging effect.

5. Include the statement, "The programs discussed above for this SC group are listed in the following table. These programs are administratively controlled by a formal review and approval process." Provide a list of the programs.

6. Demonstration of how AMPs manage effects such that the intended function(s) is(are) maintained during the period of extended operation under all CLB conditions.

- Using specifics from the aging management discussion above, explain how the aging management program(s) effectively manage(s) the SC (or SC group) aging effect such that there is reasonable assurance that the intended function will be maintained during the period of extended operation under all CLB conditions.
- For example:

  - Feedwater piping provides for pressure boundary integrity under CLB design conditions.
  - Erosion/Corrosion is plausible for feedwater piping, causing wall thinning (loss of material) which can lead to loss of pressure boundary integrity.
  - Calvert Cliffs' erosion/corrosion program will detect wall thinning and contains acceptance criteria that ensure corrective actions will be taken such

[2] Details of the frequency and criteria can be referenced.

that there is reasonable assurance that the pressure boundary integrity function will be maintained.

- Therefore, the pressure boundary integrity provided by the feedwater piping will be maintained, consistent with the CLB, throughout the period of extended operation.

III. Reference List

- Complete each Technical Report with a list of pertinent references.

5.8 Feedwater System

5.8.1 Scope

General System Description

The Condensate and Feedwater Systems are designed to provide a means for transferring the condensate from the condenser hotwell to the steam generators. The system design features provide for raising the temperature and pressure of the condensate, controlling the rate of flow to the steam generators, and the addition of chemicals and purification of the condensate.

Condensate from the hotwells is pumped by motor-driven condensate pumps through the gland steam condenser, the condensate demineralizer and precoat filtering system, and the lowest feedwater heating stages to the suction of the condensate booster pumps. These booster pumps deliver the condensate to the two turbine-driven steam generator feed pumps (SGFPs) through two parallel sets of feedwater heaters. The SGFPs pump the feedwater through two parallel high pressure heaters to the steam generators. The condensed steam from the lower pressure feedwater heating stages drains back to the condenser hotwell and from higher pressure heaters is pumped into the condensate system. The Updated Final Safety Analysis Report (UFSAR) Chapter 10 includes a system description and diagram of the condensate and feedwater systems. Specific component design data is included in Table 10-1 of the UFSAR.

A portion of the condensate flowstream is normally routed through the precoat filters and condensate demineralizers (full flow capability exists) in order to remove particulates and corrosive elements. Additionally, chemicals are added to the condensate for oxygen scavenging and pH control. The portion of the Condensate System within the scope of License Renewal is addressed in a separate section.

The scope of the Feedwater System for the purposes of the review described herein includes the equipment, instruments and controls from the suction of the SGFPs, through the feedwater heaters, the regulating valves, the flow nozzles, the feedwater isolation valves, and the feedwater header check valves to the steam generator feedwater inlet nozzles. Also included are steam generator secondary side pressure and level instrumentation loops. This instrumentation provides steam generator level control information as well as the protective functions of steam generator isolation and auxiliary feedwater initiation. The steam generator vessel is included in the Reactor Coolant System report.

The Feedwater System functional requirements are determined by the System and Structure Scoping activity of the Integrated Plant Assessment (IPA) process described in Section 2.0 of the license renewal application. The system functional requirements are:

- to transfer feedwater from the steam generator feed pump suction to the steam generators
- to regulate the flow of feedwater to the steam generators to maintain a constant water level
- to provide a means of raising the temperature of the condensate received by the feed pumps
- to provide a means for injecting chemicals into the steam generators from the chemical addition system

Scoped SCs and Their Intended Functions

The components of the Feedwater System were reviewed and those that supported the system intended functions were determined to be within the scope of review for license renewal in accordance with the requirements of 10 CFR Part 54, License Renewal Rule, as described in the CCNPP IPA Methodology included in Section 2.0 of the License Renewal Application. The components within the scope of review are those that satisfy the criteria listed in 10 CFR Part 54.4(a). The portion of the Feedwater System within the scope of license renewal includes the piping, components and instrumentation (including control and power cabling and component supports) from the inlet side of the feedwater isolation motor-operated valve (MOV) to the steam generator nozzle. Also included are steam generator secondary side water level and pressure instrumentation loops, including the root isolation valves and all downstream components (valves, tubing, instruments). Figure 5.8-1 provides a simplified diagram of the feedwater system indicating the portion of the system within the scope of review.

The following Feedwater System components within the scope of review perform an intended function without moving parts or a change in configuration or properties:

- System piping and in-line components provide the pressure retaining boundary of the system.
- Electrical control and power cabling and instrument transmitters provide electrical continuity and protect the plant safety related electrical system from faults.
- Supports for piping, tubing, cable trays and components provide structural support to system components.

These are the components of the Feedwater System that perform intended function(s) in a passive manner and meet the criteria of 10 CFR Part 54.21(a)(1)(i) as subject to an aging management review. Of these, several components are subject to replacement based on a qualified life and are therefore not subject to an aging management review in accordance with 10 CFR Part 54.21(a)(1)(ii).

The remaining components are subject to an aging management review. Several component types are common to many plant systems and perform the same intended functions. For efficiency, these are addressed separately in commodity evaluations and are not included in this section. The following identifies the disposition of these commodity components:

- Structural supports for piping, cable trays and components in the Feedwater System are evaluated for the effects of aging in the Component Supports Commodity Evaluation
- Electrical control and power cabling for components in the Feedwater System is evaluated for the effects of aging in the Electrical Cables Commodity Evaluation
- Instrument transmitters, associated tubing and tubing supports, and instrument valves in the Feedwater System are evaluated for the effects of aging in the Instrument Line Commodity Evaluation

The remaining Feedwater System components subject to an aging management review support the intended function to provide the pressure retaining boundary for the system, and were evaluated for the effects of aging. A list of the component types for Feedwater System components evaluated herein is shown in Table 5.8-1.

<u>CCNPP Main Feedwater System - Simplified Diagram</u>

Note: Not all components within the scope of License Renewal are shown

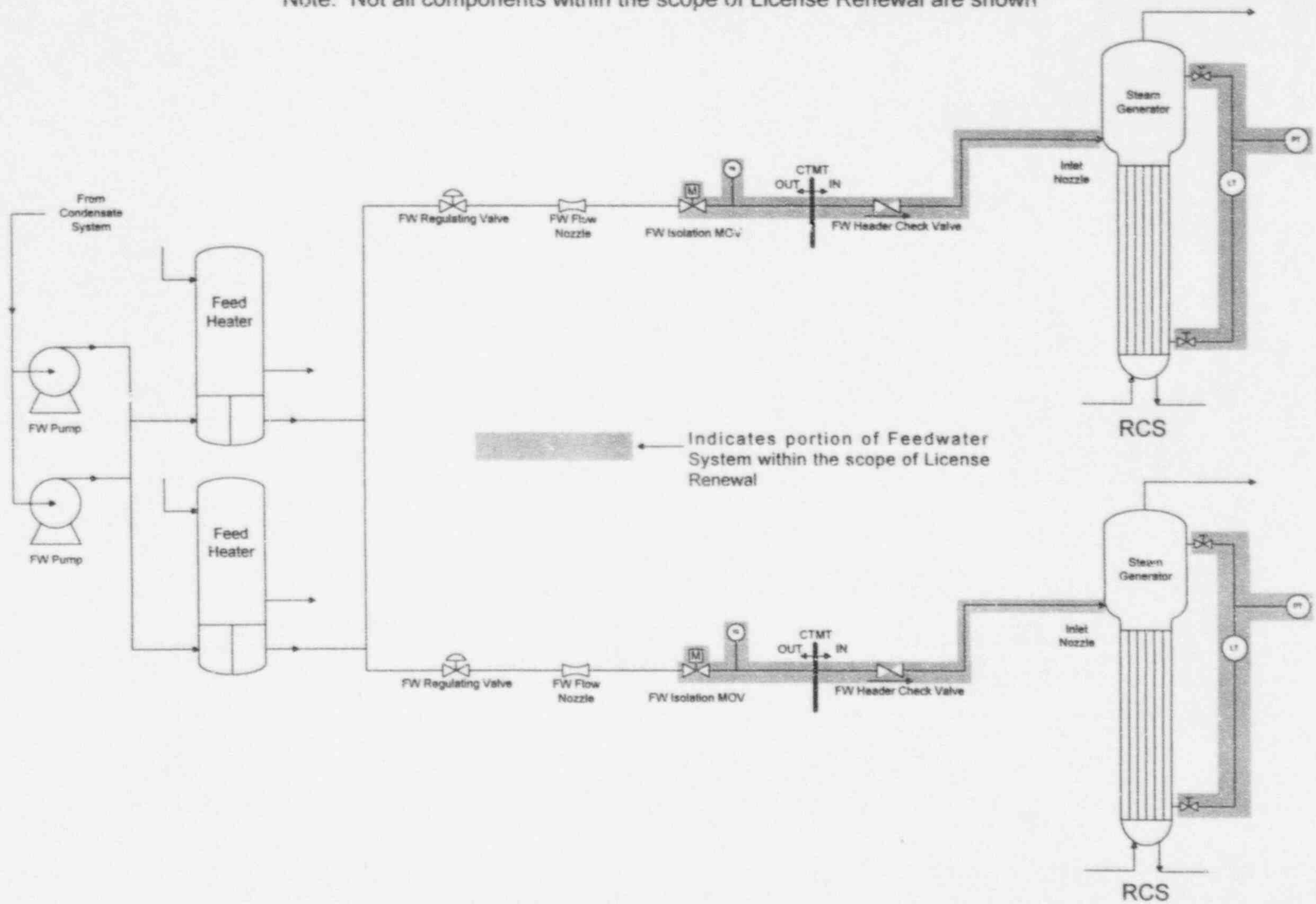

Figure 5.8-1

TABLE 5.8-1

FEEDWATER SYSTEM COMPONENT TYPES REQUIRING AMR

Piping
Check Valves
Hand Valves
Motor-Operated Valves
Temperature Elements

5.8.2 Aging Management

The following provides a discussion of the results of the aging management review for the Feedwater System scope. Hereafter, discussion of the Feedwater System is intended to be limited to the scope of components subject to an aging management review and not included in the scope of any commodity evaluation.

Operating Environment and Materials of Construction

The internal environment for the Feedwater System components is chemically treated and demineralized, high pressure water that increases with power level from 100F or less to approximately 435F at normal full power operation. System flow rates and fluid velocities are high at full power conditions. The system bulk fluid is single-phase water under all normal conditions. During plant shutdown conditions, the system may be drained or maintained full of water. System lay-up conditions are established.

The controls placed on system fluid chemistry during plant operation result in an extremely pure water environment for the Feedwater System components. These controls are established to prevent corrosion product carryover to the steam generator and to prevent an aggressive environment for corrosion within the steam generator. The fluid pH is also controlled in order to minimize corrosion and erosion corrosion of secondary system piping.

The system is subjected to thermal cycling conditions during plant power increases and decreases, and in the event of plant transients such as power runbacks or trips. The piping near the steam generator inlet nozzle is subject to thermal stratification effects at hot standby and low power levels, which can result in large, rapid thermal transients in the piping.

The external environment for the system components is ambient atmospheric air in either the auxiliary building or the containment building. The components are typically coated (painted) and insulated externally. This environment is a climate controlled atmosphere with moderate temperatures and humidity and not considered to be aggressive to component external surfaces.

The material of construction of general use in the Feedwater System is plain carbon steel and cast steel meeting various material specifications. Certain piping segments have been replaced with chromium-molybdenum (Cr-Mo) alloy steel due to erosion-corrosion concerns. The temperature element thermowell components are constructed of Cr-Mo steel.

Age-related Degradation Mechanisms

The aging management review performed for the Feedwater System included a review of several potential age-related degradation mechanisms (ARDM) to determine any that may result in aging effects that could affect the ability of a component to perform its intended function. The list of potential ARDMs considered for Feedwater System components is given in Table 5.8-2. The table also indicates which ARDMs were determined to affect the ability of a component to perform its intended function considering the period of extended operation. These are the ARDMs considered to be plausible, in accordance with the IPA Methodology (Section 2.0 of the License Renewal Application), for which the effects of aging must be demonstrated to be adequately managed so that the component intended function(s) will be maintained consistent with the CLB for the period of extended operation. Plausible ARDMs, and certain non-plausible ARDMs, are discussed further below.

Piping

The large bore Feedwater System main line piping is seamless carbon steel pipe with cast steel fittings (except sections replaced with Cr-Mo material) and the small bore drain and instrument tap piping is seamless carbon steel with forged fittings. Piping joints are butt-welded for large bore piping and socket welded for small bore piping.

Fatigue/Corrosion Fatigue As described above, the piping adjacent to the steam generator inlet nozzle has been determined to be subjected to significant thermal transients due to thermal stratification during hot standby and low power plant operation. During these operating modes, the steam generator is at or near zero power RCS temperature (~550F) and feedwater is at or near 100F. The feed ring is below the normal water level in the steam generator and the feedwater flowrate is low during these conditions. The resultant stratification of alternate layers of hot steam generator water and relatively cold feedwater causes cyclic thermal transients and associated stress reversals in the affected piping. For this reason, thermal fatigue of the feedwater piping near the steam generator is determined to be a plausible ARDM for which the effects of aging must be managed. Fatigue, if left unmitigated, can result in crack initiation and growth such that the pressure retaining boundary may not be capable of functioning under all CLB loading conditions. Additionally, the effects of corrosion in the area of cyclic stress could result in corrosion fatigue, or the combined effect of corrosion and fatigue, which can accelerate the effects of fatigue. Therefore, corrosion fatigue is also a plausible ARDM for which the effects of aging must be managed.

Since the thermal transients associated with normal plant operation, i.e., power increases and decreases and plant transients, result in a low number of stress reversals relative to the design code allowables, thermal fatigue (and corrosion fatigue) is not considered to be a plausible ARDM for piping not near the steam generator inlet nozzle.

{Phase 2 description of aging management for effects of fatigue and corrosion fatigue here}

TABLE 5.8-2

Age-Related Degradation Mechanism (ARDM) List

Potential ARDMs	Component Types					Not Plausible for System
	Piping	Check Valve	Hand Valve	MOV	Temperature Element	
Cavitation Erosion						x
Contamination/Sediment						x
Corrosion Fatigue	✓					
Crevice Corrosion	✓	✓	✓	✓	✓	
Dynamic Loading						x
Electrical Stressors						x
Erosion Corrosion	✓	✓		✓	✓	
Fatigue	✓					
Galvanic Corrosion						x
General Corrosion	✓	✓	✓	✓	✓	
Hydrogen Damage						x
Intergranular Attack						x
MIC						x
Particulate Wear Erosion						x
Pitting	✓	✓	✓	✓	✓	
Radiation Damage						x
Saline Water Attack						x
Selective Leaching						x
Stress Corrosion Cracking						x
Thermal Damage						x
Thermal Embrittlement						x
Wear						x

✓ - indicates plausible ARDM determination

Erosion Corrosion Based on the high energy and high velocity fluid conditions of the Feedwater System, erosion corrosion of the piping was determined to be a plausible ARDM for which the effects of aging must be managed. Erosion corrosion results in material loss from the pipe interior wall in areas with adverse geometry's that cause disturbances in the flowstream such as bends, tees, valves and localized internal surface irregularities. High velocity, turbulent flow erodes the metal surface, usually the protective passive corrosion film, and exposes fresh metal to corrode. This process can result in significant wall thickness reduction in a short period of time. If left unmitigated, erosion corrosion can reduce the component wall thickness that could result in loss of the pressure retaining capability under CLB design loading conditions.

{Phase 2 description of aging management for effects of erosion corrosion here}

Corrosion The carbon steel piping material is susceptible to general and localized corrosion mechanisms in a water environment. The feedwater environment, however, is purified water with a controlled pH and with oxygen concentration (and other impurities) maintained at extremely low levels (on the order of a few ppb) during normal plant operation. This environment results in limited corrosion reactions and the formation of a passive oxide layer (magnetite) that protects the pipe interior surface by preventing bare metal exposure to the water environment. As described previously, the internal environment during plant shutdown conditions is controlled through lay-up chemistry provisions, but could result in a short term aggressive environment due to high oxygen concentrations during system maintenance activities. The fluid temperature during shutdown is low (~70F) and limits corrosive attack. The system chemistry is returned to within specification prior to power operation after shutdown periods.

Although no significant corrosion is expected due to the normal operating environment, the possibility for crevices and other stagnant areas of the system result in the possibility of localized fluid chemistry outside of the specified limits that may result in corrosion. For this reason, general corrosion and crevice corrosion/pitting were determined to be plausible ARDMs for which aging effects must be managed. These mechanisms may result in localized pitting and/or general area material loss in areas of stagnant flow conditions (crevices, dead legs) that, if left unmitigated, could result in loss of the pressure retaining capability under CLB design loading conditions.

{Phase 2 description of aging management for effects of corrosion here}

Valves

The Feedwater System valves subject to AMR consist of the steam generator feedwater header check valves and feedwater isolation motor operated gate valves (MOVs), and small hand operated gate and globe valves for feedwater header drain and steam generator instrumentation root isolation service. The valves are constructed of cast or forged carbon steel material.

Erosion Corrosion The steam generator check valves and the feedwater isolation MOVs are located in the main feedwater flowstream, and therefore are subject to the high energy and high velocity fluid conditions of the Feedwater System. Erosion corrosion of the valve bodies was determined to be a plausible ARDM for which the effects of aging must be managed. Erosion corrosion can result in material loss from the component interior wall in areas with significant flow turbulence. This process can result in significant wall thickness reduction in a short period of time. If left unmitigated, erosion corrosion can reduce the component wall thickness that could result in loss of the pressure retaining capability under CLB design loading conditions.

The drain valves and instrumentation root isolation valves are not in the Feedwater System fluid flowstream and, therefore, not subject to high energy fluid flow. Erosion corrosion was determined to be non plausible for these components.

{Phase 2 description of aging management for effects of erosion corrosion here}

Corrosion The carbon steel valve material is susceptible to general and localized corrosion mechanisms in a water environment. The feedwater environment, however, is purified water with a controlled pH and with oxygen concentration (and other impurities) maintained at extremely low levels (on the order of a few ppb) during normal plant operation. This environment results in limited corrosion reactions and the formation of a passive oxide layer (magnetite) that protects the component interior surface by preventing bare metal exposure to the water environment. As described previously, the internal environment during plant shutdown conditions is controlled through lay-up chemistry provisions, but could result in a short term aggressive environment due to high oxygen concentrations during maintenance activities. The fluid temperature during shutdown is low (~70F) and limits corrosive attack. The system chemistry is returned to within specification prior to power operation after shutdown periods.

Although no significant corrosion is expected due to the normal operating environment, the possibility for crevices and other stagnant areas of the system such as the header drain lines and steam generator instrumentation loops result in the possibility of localized fluid chemistry outside of the specified limits that may result in corrosion. For this reason, general corrosion and crevice corrosion/pitting were determined to be plausible ARDMs for the system valves for which aging effects must be managed. These mechanisms may result in localized pitting and/or general area material loss in areas of stagnant flow conditions (crevices, dead legs such as the header drains and instrumentation loops, socket welds) that, if left unmitigated, could result in loss of the pressure retaining capability under CLB design loading conditions.

{Phase 2 description of aging management for effects of corrosion here}

Temperature Element Thermowells

The steam generator feedwater inlet temperature instruments are installed in thermowells in the main feedwater piping. The thermowells are fabricated of 2 1/4 Cr - 1 Mo steel alloy material and are welded to the piping via a half coupling fitting.

Erosion Corrosion The thermowell is located in the main feedwater flowstream, and therefore is subject to the high energy and high velocity fluid conditions of the Feedwater

System. Erosion corrosion of the thermowell was determined to be a plausible ARDM for which the effects of aging must be managed. Erosion corrosion can result in material loss from the component in areas with significant flow turbulence. This process can result in significant wall thickness reduction in a short period of time. Erosion corrosion of the thermowells is expected to be less significant than for other feedwater components due to the Cr-Mo material of construction. However, if left unmitigated, erosion corrosion can reduce the component wall thickness that could result in loss of the pressure retaining capability under CLB design loading conditions.

{Phase 2 description of aging management for effects of erosion corrosion here}

Corrosion The limited corrosion resistance of the Cr-Mo thermowell material results in susceptibility to general and localized corrosion mechanisms in a water environment. The feedwater environment, however, is purified water with a controlled pH and with oxygen concentration (and other impurities) maintained at extremely low levels (on the order of a few ppb) during normal plant operation. This environment results in limited corrosion reactions and the formation of a passive oxide layer (magnetite) that protects the component interior surface by preventing bare metal exposure to the water environment. As described previously, the feedwater system internal environment during plant shutdown conditions is not specifically controlled through lay-up chemistry provisions, and could result in a short term aggressive environment due to high oxygen concentrations. The fluid temperature during shutdown is low (~70F) and limits corrosive attack. The system chemistry is returned to within specification prior to power operation after shutdown periods.

Although no significant corrosion is expected due to the normal operating environment, the possibility for crevices and other stagnant areas of the system result in the possibility of localized fluid chemistry outside of the specified limits that may result in corrosion. For this reason, general corrosion and crevice corrosion/pitting were determined to be plausible ARDMs for the thermowells for which aging effects must be managed. These mechanisms may result in localized pitting and/or general area material loss in areas of stagnant flow conditions (crevices) that, if left unmitigated, could result in loss of the pressure retaining capability under CLB design loading conditions.

{Phase 2 description of aging management for effects of corrosion here}

APPENDIX A

TECHNICAL INFORMATION

7.1 Structures

7.1.1 Scoping

7.1.1.A Structures Description

The plant site for CCNPP is described in Chapter 1 of the UFSAR. The plant arrangement consists of numerous structures which are shown on UFSAR Figures 1-4 through 1-30 and further discussed in Chapter 5. Structures provide many purposes at CCNPP including foundation, support, shielding, and containment for plant equipment.

The following is a general layout description of the major structures at CCNPP. The Turbine Building for the CCNPP is oriented parallel and adjacent to the shoreline of the Chesapeake Bay with the twin Containment Structures and the Auxiliary Building located on the west, or landward, side of the Turbine Building. The service buildings and the intake and discharge structures are on the east, or bay side, of the Turbine Building (UFSAR Figure 1-2).

The **Intake Structure** is a seismic category I structure situated to the east of the turbine building and is primarily a reinforced concrete structure, founded on a slab varying in elevation from -26'0" to -14'3". It houses 12 circulating water pumps supplying water from the Chesapeake Bay to the condensers, located under the turbine generators, and to 6 salt water pumps. To protect the condensers from foreign bodies present in the Bay water, trash racks and traveling water screens are provided. Vertical guides are provided down the sides of each intake channel to receive stop-logs to permit drainage for inspection and maintenance. Running the full length of the structure is a gantry crane having a lifting capacity of 35 tons.

The **Turbine Building Structure** is situated to the west of the intake structure and to the east of the auxiliary building. It houses the two turbine generators, condensers, feedwater heaters, condensate and feed pumps, turbine auxiliaries, and certain of the switchgear assemblies. The turbine building structure is an integrated steel structure, with metal siding, supported on reinforced concrete foundations. Included in the turbine building are the turbine generator bays, heater bays , and the turbine-generator concrete pedestals which project through the building to the operating deck at elevation 45 feet. The turbine generator units 1 and 2 are separated by an expansion joint in the super-structure. The circulating water intake and discharge conduits are incorporated into the spread footings. The turbine building is a seismic category II structure with the exception of the auxiliary feedwater pump enclosure, which is seismic category I. All of the structural steel columns, beams and roof trusses of the building have been designed as independent members and in accordance with AISC.

The **Auxiliary Building Structure** is situated to the west of the turbine and to the east of the containment structures. It is primarily a reinforced concrete structure with a mat foundation. The foundation supports a structural steel and reinforced concrete frame which consists mainly of reinforced concrete walls and floors. On the top structure and over the fuel handling area is a secondary steel frame structure with missile-resistant concrete walls and roof which houses the spent fuel crane. Facilities related to the NSSS which are located in the auxiliary building include:

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- New and spent fuel handling, storage and shipment
- Waste processing system
- Safety injection system
- Various electrical distribution systems
- Component cooling
- Emergency diesel generator rooms
- Control room
- Chemical addition system
- Spent fuel pool cooling system
- Chemical and volume control system
- Containment spray

The auxiliary building is a seismic category I structure below 69' elevation. The reinforced concrete design is in accordance with American Concrete Institute (ACI) 318-63 and the structural steel is in accordance with American Iron and Steel Council (AISC).

Each **Containment Structure** is location west of the auxiliary building with a connective boundary to the auxiliary building formed by the shape of the containment. Each is a seismic category I structure, housing the reactor and other NSSS components consisting of a reactor, SGs, RCPs, a pressurizer, and some of the reactor auxiliaries which do not normally require access during power operation. The containment consists of a reinforced concrete cylinder and a shallow domed roof which rests on a reinforced concrete foundation slab. The concrete cylinder and dome have a post tensioned contraction design. Attached to the inside of the containment structure is a coated carbon steel liner. There are three personnel and equipment access openings in the containment: a two-door personnel lock, a large diameter single door equipment hatch, and a two-door personnel escape lock. The primary containment has numerous penetrations for piping and electrical connections. These penetrations are leak tight, inerted assemblies, welded to the containment liner. A fuel transfer tube penetration in the containment is provided permit fuel movement between the refueling pool in the containment and the spent fuel pool in the auxiliary building. Two sumps are provided in the containment floor: a normal and emergency sump.

The **Fuel Oil Storage Tank No. 21 Enclosure** is a protective building which encloses the fuel oil storage tank no. 21. The building is seismic category I and is constructed of reinforced concrete.

The **Condensate Storage Tank #12 Enclosure** is a seismic category I reinforced concrete structure located north of the turbine building in the tank farm area. It houses Condensate Storage Tank 12 which is shared between the units.

Other Structures at CCNPP are either included within the structures listed above, determined to be outside the License Renewal scope, or covered under a separate license.

Structures have been grouped together for the purposes of writing this section since they are designed and constructed in a similar manner, comprised of the same materials, subject to the same aging mechanisms, and are managed by similar plant programs. Each structure within the scope of License Renewal and subject to an aging management review has a separate aging management review report which is listed in the references at the end of this section.

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7.1.1.B Scoped SCs and Their Intended Functions

In accordance with the IPA methodology described in Section 2.0, the following structures were identified to be within the scope of license renewal:

- Containment Structure
- Auxiliary Building
- Intake Structure
- Turbine Building (Aux. Feedwater Pump Room)
- No. 21 Fuel Oil Storage Tank (FOST) Enclosure
- No. 12 Condensate Storage Tank (CST) Enclosure

During the scoping process, structural components were divided into 4 structural categories and 1 system category based on their design and materials.

1. Concrete Components,
2. Structural Steel Components,
3. Architectural Components,
4. Unique Components, and
5. System Type Components.

Within those five structural component groups, 59 different structural component types were identified as contributing to the intended functions of the structure. A table listing these component types and indicating the structures to which the component types are applicable is given as Table 7.1-1.

Several structural component types are common to many plant systems and perform the same passive intended functions, (e.g., piping and component supports.) As described in Section 2.0, these are addressed separately as commodity groups and are not included in this section. They include the following:

- Structural supports that are connected to the structures are evaluated for the effects of aging in the Component Supports Commodity Evaluation
- Cranes and fuel handling equipment which is connected to the structures is evaluated for the effects of aging in the Cranes and Fuel Handling Commodity Evaluation
- Electrical control and power cabling for components in the Containment System is evaluated for the effects of aging in the Electrical Cables Commodity Evaluation

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TABLE 7.1-1

STRUCTURAL COMPONENT TYPES REQUIRING AMR

	Containment	Auxiliary Building	Intake Structure	Turbine Building	No. 21 FOST Enclosure	No. 12 CST Enclosure
Concrete (Including Reinforcing Steel)						
Foundations (Footings, beams, and mats)		✓	✓		✓	✓
Columns	✓	✓	✓			
Walls		✓	✓	✓	✓	✓
Beams	✓	✓	✓			
Ground Floor Slabs/Equipment Pads	✓	✓	✓	✓		
Elevated Floor Slabs	✓	✓	✓	✓		
Roof Slabs		✓	✓		✓	✓
Cast-In-Place Anchors/Embedments•	✓	✓	✓	✓	✓	✓
Ductbanks				✓		
Grout	✓	✓	✓	✓	✓	✓
Concrete Blocks (Shielding)		✓				
Removable Missile Shield	✓					
Fluid Retaining Walls and Slabs		✓	✓	✓		
Masonry Block Walls		✓				
Post-Installed Anchors•	✓	✓	✓	✓	✓	
Structural Steel						
Columns•	✓	✓				
Beams•	✓	✓	✓	✓	✓	✓
Baseplates•	✓	✓	✓	✓	✓	✓
Floor Framing•	✓	✓	✓	✓		
Roof Framing•		✓	✓		✓	✓
Roof Trusses•		✓				
Bracing•	✓	✓	✓	✓	✓	
Platform Hangers•	✓	✓	✓	✓	✓	

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TABLE 7.1-1 (Cont.)

STRUCTURAL COMPONENT TYPES REQUIRING AMR

	Containment	Auxiliary Building	Intake Structure	Turbine Building	No. 21 FOST Enclosure	No. 12 CST Enclosure
Structural Steel						
Decking•	✓	✓	✓	✓	✓	✓
Jet Impingement• Barriers		✓		✓		
Liners	✓	✓				
Floor Grating•	✓		✓	✓	✓	
Checkered Plates•	✓		✓			
Stairs and Ladders•			✓	✓	✓	
Architectural Components						
Building Siding Clips•				✓		
Fire Doors, Jambs, and Hardware•		✓	✓	✓		
Access Doors, Jambs, and Hardware•		✓	✓	✓		
Caulking and Sealants		✓	✓	✓	✓	✓
Coatings (including galvanizing)	✓					
Unique Components						
Concrete Basemat	✓					
Concrete Dome	✓					
Concrete Containment Walls	✓					
Primary/Secondary Shield Wall	✓					
Refueling Canal	✓					
Post Tensioning System	✓					
Crane Girder•	✓					

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TABLE 7.1-1 (Cont.)

STRUCTURAL COMPONENT TYPES REQUIRING AMR

	Containment	Auxiliary Building	Intake Structure	Turbine Building	No. 21 FOST Enclosure	No. 12 CST Enclosure
Unique Components						
Lubrite Plates*	✓					
Maranite XL Board	✓					
New Fuel Rack Assembly*		✓				
Spent Fuel Storage Racks		✓				
Monorail*		✓				
Cask Handling Crane Rail/Supports*		✓				
Lead Brick Shielding		✓				
Pipe Whip Restraints*		✓				
Roll-Up Doors*		✓				
Expansion Joints		✓				
Watertight Doors*		✓	✓	✓		
Sluice Gates*			✓			
Anchor Brackets*					✓	
System Type Components						
Electrical Penetrations (Non-EQ)	✓					
Mechanical Penetrations	✓					
Fuel Transfer Tube/ Bellows	✓					
Personnel Airlocks	✓					
Equipment Hatch	✓					

* Indicates that component type is included under the heading "Steel Components" in the discussion addressing the results of the AMR and in Table 7.1-4.

In accordance with the IPA methodology, intended functions were identified for each structure. These results are present in Table 7.1-2:

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While the first seven functions are of a structural nature, the eighth function is a system-type function provided by the EQ electrical penetrations. Aging management for these penetrations is provided by the CCNPP 50.49 Program. The demonstration for this program is provided in a separate LRA section.

TABLE 7.1-2

INTENDED FUNCTIONS OF STRUCTURES

Function	Containment	Auxiliary Building	Intake Structure	Turbine Building	No. 21 FOST Enclosure	No. 12 CST Enclosure
1. Provide structural and/or functional support to safety-related equipment	✓	✓	✓	✓	✓	✓
2. Provide shelter/protection to safety-related equipment. (This function includes radiation protection for EQ equipment and high energy line break-related protection equipment.)	✓	✓	✓	✓	✓	✓
3. Serve as a pressure boundary or a fission product retention barrier to protect public health and safety in the event of any postulated DBEs	✓	✓				
4. Serve as a missile barrier (internal or external)	✓	✓	✓	✓	✓	✓
5. Provide structural and/or functional support to NSR equipment whose failure could directly prevent satisfactory accomplishment of any of the required safety-related functions (Example: seismic Category II over I design considerations)	✓	✓	✓	✓	✓	
6. Provide flood protection barrier (internal flooding event)	✓	✓	✓	✓		
7. Provide a rated fire barrier to confine or retard a fire from spreading to or from adjacent areas of the plant	✓	✓	✓	✓		
8. Maintain the functionality of electrical components addressed by the EQ program.	✓					

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Table 7-1.3 provides the correlation between component types in the structure and their intended function(s). Each component type necessary for an intended function is designated as within the scope of LR.

TABLE 7.1-3

STRUCTURAL COMPONENTS WHICH CONTRIBUTE TO INTENDED FUNCTIONS
(by function number see table 7.1-2)

COMPONENT	Intake Structure	Fuel Oil Storage Tank Enclosure	Condensate Tank Enclosure	Turbine Building	Containment	Auxiliary Building
Access Doors, Jambs, Hardware	2			2, 6, 7		2
Anchor Brackets		1				
Baseplates	1, 5	2, 4	2, 4	1, 2, 4, 5, 7	1,5	1, 5
Building Siding Clips				2		
Cast-In-Place Anchors/Embedments	1, 2, 6, 7	1, 2, 4, 5	1, 2, 4	1, 2, 6, 7	1, 5	1
Checkered Plate	2				1, 5	
Coating	2	1, 2, 4, 5	1, 2	1, 2, 4, 5, 7	1, 5, 7	
Concrete Beams	2, 4				1, 5	1, 5
Concrete Columns	2, 4, 7				1, 5	1, 5
Concrete Roof Slab	2	2, 4	2, 4		1, 2, 3, 4, 5, 7	2, 4
Concrete Walls	1, 2. 4, 7	2, 4	2, 4	1, 2, 4, 6, 7	1, 2, 3, 4, 5, 6, 7	1, 2, 4, 5, 6, 7
Ductbank				1, 2		
Elevated Floor Slabs	1, 2			1, 2, 6, 7	1, 5	1, 2 , 5 ,7
Fire Doors, Jambs, Hardware	2, 7			2, 6, 7		7
Floor Framing	1, 5			1, 2, 7	1, 5	1, 5
Floor Grating	5	5		5	1, 5	
Fluid Retaining Walls And Slabs	1 ,2, 6			1, 2, 6, 7		1
Foundations	2	1, 2	1, 2			1, 5
Ground Floor Slabs and Equipment Pads	1, 2			1, 2, 4, 6, 7	1, 5	1, 5
Grout	1, 2	1, 2, 4, 5	2	1, 2, 6, 7	1, 5	1, 5
Jet Impingement Barriers				4		2
Platform Hangers	5	5		5	1, 5	1, 5
Post-Installed Anchors	2, 5	5		4, 5	1	1, 5
Roof Framing	2	2, 4	2, 4			1, 4, 5

TABLE 7.1-3 (CONT.)

STRUCTURAL COMPONENTS WHICH CONTRIBUTE TO INTENDED FUNCTIONS
(by function number see table 7.1-2)

COMPONENT	Intake Structure	Fuel Oil Storage Tank Enclosure	Condensate Tank Enclosure	Turbine Building	Containment	Auxiliary Building
Sluice Gates	1					
Stairs And Ladders	5	5		5		
Steel Beams	1, 2	2, 4	2, 4	1, 2, 7	1, 5	1, 5
Steel Bracing	2, 5	5		4	1, 5	1, 5
Steel Columns					1,5	1, 5
Steel Decking	2	2, 4	2, 4	1, 2, 7	1, 5	1, 5
Watertight Doors	6			2, 6, 7		6, 7
Primary Shield Wall, Secondary Shield Wall, Lubrite Plates, Post-Tensioning System, Containment Liner, Refueling Canal (Concrete, Liner) , Concrete Basemat, Crane Girder, Basemat Liner, Penetrations (Sleeves, Bellows), Personnel Airlocks, Equipment Hatch, Removable Missile Shield, Maranite XL Board					1 - 7	
Concrete Block (Shielding), Masonry Block Walls, Roof Trusses, Steel Liners, Lead Brick Shielding, Roll-Up Door, New Fuel Rack Assembly, Monorail, Cask Handling Crane Rail/Supports, Pipe Whip Restraints, Expansion Joints, Spent Fuel Storage Racks						1, 2, 4, 5 ,6, 7

7.1.2 Aging Management

The age-related degradation mechanisms (ARDMs) considered for structures are presented in Table 7.1-4. The table is divided into two parts: Structural Type Components and Systems Type Components because of the ARDM differences for structures versus systems. Based upon environment, design and the results of inspection, a number of these mechanisms were determined to not be plausible. The plausible age-related degradation mechanisms and the components affected are identified in Table 7.1-4

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TABLE 7.1-4

STRUCTURES POTENTIAL AND PLAUSIBLE ARDMs
(by structure number listed below table)

ARDM	Potential	Plausible	Components Affected
Structural Type Components (Concrete, Structural Steel, Architectural, Unique)			
Freeze-Thaw	1, 2, 3, 5, 6	X	
Leaching of Calcium Hydroxide	1, 2, 3, 4, 5, 6	X	
Aggressive Chemical Attack on Concrete	1, 2, 3, 4, 5, 6	1, 2, 3, 4	Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs
Reactions with Aggregates	1, 2, 3, 4, 5, 6	X	
Corrosion of Embedded Steel/rebar	1, 2, 3, 4, 5, 6	1, 2, 3, 4	Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs
Abrasion and Cavitation	3	X	
Cracking of Masonry Block Walls	2	X	
Settlement	1, 2, 3, 4, 5, 6	X	
Corrosion of Steel	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	Steel Components (* in Table 7.1-1)
Corrosion of Line.	1, 2	1, 2	Liners
Corrosion of Tendons	1	1	Post Tensioning System
Prestress Losses	1	1	Post Tensioning System
Weathering	1, 2, 3, 4, 5, 6	2, 3, 4, 5, 6	Caulking and Sealants, Expansion Joints
Elevated Temperature	1, 2	X	
Irradiation	1, 2	X	
Fatigue	1, 2, 3, 4	X	
System Type Components			
General corrosion/oxidation	1	1	Non-EQ Electrical/Mechanical Penetrations, Personnel Airlocks, Equipment Hatch
Pitting/Crevice Corrosion	1	X	
IASCC	1	X	
SCC/IGSCC/IGA	1	X	
Microbiologically Influenced Corrosion	1	X	
Thermal Aging	1	X	
Stress Relaxation	1	X	

1 Containment Structure **3 Intake Structure** **5 FOST #21 Enclosure**
2 Auxiliary Building **4 Turbine Building** **6 CST #12 Enclosure**
X - not plausible

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7.1.2.A Structure Environments and Materials of Construction

The following defines the environment and materials of construction for structures by dividing them into categories of external and internal:

External Above Grade Environmental Conditions - The above grade portion of structures are exposed to the atmosphere. There is no heavy industry nearby CCNPP to add chemicals to the atmosphere but, due to the close proximity of the Chesapeake Bay the concrete could be exposed to an environment containing chloride ions.

Concrete and/or coated steel are exposed to the external environmental conditions.

External Below Grade Environmental Conditions - The below grade portions of structures are comprised of reinforced concrete in contact with soil and groundwater. The pH of groundwater was established at construction to be 7.5.

The ground area around the containments has a groundwater dewatering system that was installed during construction to maintain a stable groundwater level at El. - 10.0 ft.

The concrete fluid retaining walls of the intake structure are in contact with the Chesapeake Bay water which is an environment containing chloride ions.

For the purposes of the aging evaluation, the internal environmental conditions for the tank enclosures which are open to the atmosphere were considered to be the same as the external environment. For the remaining structures the internal environment is listed below:

Internal Environmental Conditions

Containment Structure - The maximum design ambient air temperature is 120°F for normal, startup, and shutdown operation. The design ambient air pressure is 14.7 psia. Ambient air pressure is limited to -1.0 to +1.8 psig during normal plant operation . The design ambient air relative humidity during normal plant operation is 50% at 120°F and 14.7 psia .

There are both concrete and coated steel exposed to the internal environmental conditions.

Auxiliary Building, Intake Structure, Turbine Building - Ambient temperatures are controlled by plant ventilation systems as specified in UFSAR, Chapter 9. The plant ventilation systems are designed to provide minimum (winter) and maximum (summer) building air temperatures as specified in UFSAR, Chapter 9, Table 9-18. Certain areas are maintained by safety related ventilation systems. These areas are maintained by design, at, or below the maximum design temperature identified in UFSAR, Chapter 9, Table 9-18, during UFSAR, Chapter 14 events. The remaining areas of the auxiliary building, turbine building and, intake structure are ventilated by non-safety related (NSR) ventilation systems and are maintained at or below the maximum design temperatures.

UFSAR, Appendix 10A, Section 10A.3.20 and UFSAR, Appendix 10A, Section 10A.4.1.20 define the pressure as 0 psig. General plant areas are at atmospheric pressure. Certain Auxiliary Building areas are maintained positive or negative to the ambient air pressure with respect to surrounding areas by the ventilation system for control of airborne releases.

There are no design humidity requirements. The UFSAR documents that expected conditions are based on the design of the heating and ventilation system only.

There are both concrete and coated steel exposed to the internal environmental conditions.

7.1.2.B Plausible Aging Mechanisms

This section provides a discussion of the results of the aging management review (AMR) for Structures. Hereafter, discussion of Structures is intended to be limited to the scope of components subject to an aging management review and not included in the scope of any commodity evaluation. There are however, certain ARDMs such as Freeze-Thaw, Leaching of Calcium Hydroxide, and Settlement that were determined not to be plausible for CCNPP based on the following site specific justification. These will be discussed before the results of the aging evaluation are provided for the plausible ARDMs.

Freeze-Thaw The CCNPP site is located in the geographic region considered subject to severe weathering conditions. Although freeze-thaw cycles can degrade concrete components that are exposed to cold temperatures and moisture, components subject to AMR were constructed with concrete designed to maximize its resistance to freeze-thaw. A walkdown inspection of the Unit 1 containment structure performed in 1992 found no indication of freeze-thaw effect on the concrete structures had occurred during the first 20 years of operation. This finding substantiated further the conclusion that freeze-thaw is not a plausible aging mechanism and will not have to have any impact on structural integrity for these structural components.

Leaching of Calcium Hydroxide - The external concrete surfaces at CCNPP are exposed to water. No ponding or hydraulic pressure will form to leach the calcium hydroxide. Although the below grade concrete could be subjected to hydraulic pressure due to underground water, the concrete mix was designed for low permeability and high compressive strength which provide the best protection against leaching. This conclusion is supported by a 1992 walkdown inspection during which only minor traces of leaching marks were detected in various areas of the concrete structures. These indications were judged to have no impact on structural integrity. Therefore, leaching of calcium hydroxide is not a plausible aging mechanism for any concrete structural components.

Settlement - CCNPP's structures are situated on Miocene soil, which is exceptionally dense and will support heavy foundation loads. Additionally, the structural load on the containment basemat is about the same as the removed overburden weight. Therefore, the soil bearing stress is well below its ultimate bearing capacity, and the long-term settlement is predicted to be only 1/2 inch. In addition, the settlement rate declined after completion of construction, and the groundwater table is maintained by the dewatering system. Therefore, settlement is not a plausible aging mechanism for the structural components .

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The results of the aging evaluation on Concrete components is presented below:

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs, Aggressive Chemicals on Concrete

Aggressive Chemical Attack on Concrete was determined to be plausible for Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only) and Intake Structure Fluid Retaining Walls and Slabs.

These concrete component types are in environments subject to wet conditions where the water could be acidic. Concrete is vulnerable to degradation by strong acids which can increase porosity and permeability of concrete, reduce its alkalinity content at the surface of the attack, reduce strength, and render the concrete subject to further deterioration. Portland cement concrete is not acid-resistant although varying degrees of resistance can be achieved depending on the materials used and the attention to placing, consolidating, and curing. No Portland cement concrete, regardless of its composition, will withstand exposure to highly acidic fluids for long periods. Below grade, sulfate solutions of sodium, potassium, and magnesium sometimes found in groundwater may attack concrete, often in combination with chlorides.

The groundwater pH was determined to be 7.5 at original construction but, because the present day chemical quality is unknown aggressive chemical attack is plausible for below grade portions of concrete.

Since the Chesapeake Bay water contains chemicals that might attack the concrete, aggressive chemical attack is plausible for the Intake Structure Fluid Retaining Walls and Slabs.

Sulfate attack produces significant expansive stresses within the concrete leading to cracking, spalling, and strength loss. Once established, these conditions allow further exposure to aggressive chemicals.

(phase 2 description of aging management for effects of ARDM here)

Corrosion of Embedded Steel/rebar was determined to be plausible for Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only) and Intake Structure Fluid Retaining Walls and Slabs.

These concrete component types are in environments subject to wet conditions where the water could be acidic. The environments which induce corrosion of reinforcing steel, embedded steel, and cast-in-place anchor bolts are similar. Concrete's high alkalinity provides an environment around embedded steel/rebar and protects them from corrosion. If the pH is lowered, corrosion may occur. When moisture and oxygen are present, the presence of water-soluble chloride ions can accelerate corrosion. A reduction in pH can be caused by the leaching of alkaline products through cracks, or by the entry of acidic materials, or by carbonation. Chlorides can be present in constituent materials of the original concrete mix (i.e., cement, aggregates, admixtures, and water), or they can be introduced environmentally. The severity of corrosion is influenced by the properties and type of cement and aggregates and the concrete moisture content.

The groundwater pH was determined to be 7.5 at original construction but, because the present day chemical quality is unknown aggressive chemical attack is plausible for below grade portions of concrete.

Since the Chesapeake Bay water contains chemicals and chloride ions that might attack the concrete, aggressive chemical attack is plausible for the Intake Structure Fluid Retaining Walls and Slabs.

Corrosion products have a volume greater than the original metal. The presence of corrosion products subjects the concrete to tensile stress, eventually causing hairline cracking, followed by rust staining, spalling, and more severe cracking. These actions will expose more embedded steel/rebar to a potentially corrosive environment and cause further deterioration in the concrete. A loss of bond between the concrete and embedded steel/rebar will eventually occur, along with a reduction of steel cross section. Rebar corrosion can cause deterioration of concrete from a series of hairline cracking, rust staining, spalling, and more severe cracking. These conditions can ultimately impair structural integrity.

(phase 2 description of aging management for effects of ARDM here)

The results of the aging evaluation on Steel components is presented below:

<u>Steel Components</u>

Corrosion of Steel was determined to be plausible for Steel Components (items marked with an asterisk in Table 7.1-1).

These steel component are in environments subject to humid conditions. Exposed steel corrodes in the presence of moisture and oxygen as a result of electrochemical reactions. Initially, the exposed steel surface reacts with oxygen and moisture to form an oxide film as rust. Once the protective oxide film has been formed and if it is not disturbed by erosion, by alternating wetting and drying, or by other surface actions, the oxidation rate will diminish rapidly with time. Chlorides increase the rate of corrosion by increasing the electrochemical activity.

Since steel is subject to corrosion, all exposed steel surfaces were coated with paint during construction. Degraded paint coatings can lead to exposed steel and corrosion. Therefore, corrosion of steel is plausible for these component types.

(phase 2 description of aging management for effects of ARDM here)

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Liners

Corrosion of Liner was determined to be plausible for Liners. Liners are provided for the containment, refueling pool, and spent fuel pool. They consist of either carbon steel or stainless steel.

Carbon Steel Liner

The containment liner is composed of carbon steel. The discussion here is similar to that for steel components with the difference being that the environment is internal to the containment. Electrochemical corrosion to carbon steel is caused by exposure to moisture conditions. The humidity levels in the containment can vary from 0-50 %. During construction a 3 mil primer paint coat and a 6 mil finish paint coat was applied to the liner. Degraded paint coatings can lead to exposed steel and corrosion. Therefore, corrosion of steel is plausible for the containment liner.

Continued long term corrosion can reduce liner plate thickness which compromises the pressure retention capability of the liner.

Stainless Steel Liner

The refueling pool and spent fuel pool liners are composed of stainless steel SA-240 Type 304. With respect to material susceptibility, austenitic stainless steels, such as SA-240 Type 304, are prone to SCC, particularly when sensitization is present as in heat affected zones and at creviced geometries in the presence of borated water.

In a sensitized condition, Type 304 stainless steel may develop intergranular stress corrosion cracking (IGSCC). The heat-affected zones of welds in Type 304 stainless steel are potential sites for IGSCC. IGSCC occurs when changes in the microstructure take place due to the welding heat, rendering the heat affected zones "sensitized" and when high residual stresses occur in and around the welds. The degree of sensitization depends on the metal's composition.

Therefore, corrosion of steel is plausible for the refueling pool and spent fuel pool liners.

Continued long term corrosion can reduce liner plate thickness which compromises the pressure (fluid) retention capability of the liner.

(phase 2 description of aging management for effects of ARDM here)

The results of the aging evaluation on Unique components is presented below:

Post Tensioning System

Corrosion of Tendons was determined to be plausible for Post Tensioning System.

Each tendon consists of 90 1/4 inch-diameter wires. These wires are comprised of carbon steel which in a humid environment could corrode. The potential for corrosion of tendons was considered in the original design. Therefore, a petroleum-based grease was used in the tendon sheathing to protect the tendon. When corrosion of prestressing tendons occurs, it is generally in the form of localized corrosion, and is attributed to pitting, stress corrosion, hydrogen embrittlement, or some combination of these. Pitting is a highly localized form of corrosion. The primary parameter affecting its occurrence and rate is the environment surrounding the metal. The presence of halide ions, particularly chloride ions, is associated with pitting corrosion.

Degraded grease can lead to exposed tendons and corrosion. Therefore, corrosion of tendons is plausible.

Corrosion of prestressing wires causes cracking or a reduction in the wire's cross-sectional area. In either case, the prestressing forces applied to the concrete are reduced. If the prestressing forces are reduced below the design level, a reduction in design margin results.

Prestress Losses was determined plausible for Post Tensioning System.

As the plant ages, tendons that were prestressed during construction tend to lose tension. Termed prestress losses, these reductions in stress are not readily observable. Several factors contribute to prestress loss:

- stress relaxation of the prestressing wire,
- shrinkage, creep, and elastic deformation of the concrete,
- anchorage seating losses,
- tendon friction, and
- reduction in wire cross section due to corrosion.

With the exception of corrosion-induced wire cross sectional loss, prediction of prestress losses were calculated during design to ensure the containment can maintain its pressure capacity under postulated design basis events inside the containment. These calculated prestress losses assumed a 40 year life. Prestress losses past the 40 year point have not yet been determined. Therefore, this ARDM is determined to be plausible.

(phase 2 description of aging management for effects of ARDM here)

Caulking and Sealants, Expansion Joints

Weathering was determined to be plausible for Caulking and Sealants, and Expansion Joints.

Components located in an environment that is exposed to ambient conditions are susceptible to degradation due to weathering. Aging mechanisms associated with weathering include exposure to sunlight (ultraviolet exposure), change in humidity, ozone cycles, temperature and pressure fluctuations, and snow, rain, or ice. Therefore, weathering is plausible for the these component types

APPENDIX A

TECHNICAL INFORMATION

The effects of weathering on theset materials are exhibited by a decrease in elasticity, an increase in hardness, and shrinkage.

(phase 2 description of aging management for effects of ARDM here)

The results of the aging evaluation on System type components is presented below:

Non-EQ Electrical/Mechanical Penetrations, Personnel Airlocks, and Equipment Hatch

General corrosion/oxidation was determined to be plausible for Non-EQ Electrical/Mechanical Penetrations, Personnel Airlocks, Equipment Hatch.

These coated carbon steel components types are exposed to the internal environment of the containment. The humidity levels in the containment can vary from 0-50 %. Carbon steel will corrode in the presence of moisture and oxygen. Degraded paint coatings can lead to exposed steel and corrosion. Therefore, corrosion of steel is plausible for the these component types.

The effects of general corrosion/oxidation would be eventual loss of carbon steel material and inability of the structural component to perform its pressure boundary function.

(phase 2 description of aging management for effects of ARDM here)

Open Issue from June 20, 1996 NRC Meeting

Including Codes and Standards Information in LR Technical Reports

July 3, 1996

Statement of Issue:

NRC has commented that they would like for BGE to include the ASME, IEEE, ACI, etc. code or standard applicable to the structure or system in LR technical reports.

BGE position:

When the code or standard that the component was built to plays a key role in supporting BGE's demonstration regarding aging management review of structures or components, the information is provided and appropriately referenced.

Also, BGE believes that the UFSAR contains most of this information, especially for the electrical and civil systems.

If the desired information is not provided in the technical report and is not in the UFSAR, and NRC believes they need it in order to concur with BGE's aging management demonstration, NRC can request the specific information and BGE will provide it.

Lists of Structures and Components Subject to Aging Management Review

Statement of Issue:

An NRC position has been presented which states that lists of structures and components subject to aging management review must be maintained on site to support the summary level lists in the license renewal application. The BGE process produces such lists for systems but does not produce a component-by-component list for structural components.

Discussion

1. The License Renewal Rule at §54.21(a)(1) requires the applicant to provide, in the license renewal application, a list of structures and components subject to aging management review. In previous discussions, the NRC has indicated that the form of this submitted list may be in a grouped format for efficiency and not necessarily include an item-by-item listing of individual structures and components.
2. During the NEI Pilot Demonstration visits at Calvert Cliffs and elsewhere, the NRC noted an inconsistency with respect to the information maintained on site to support the list of SCs subject to aging management review contained in the License Renewal Application. Because of this observation, the NRC has developed a "position" on this issue.
3. After conducting internal discussions, the NRC Staff presented the following three part position at a meeting with BGE on June 20, 1996:
   - The list of SCs subject to AMR in the LR submittal should be in sufficient detail such that there is reasonable assurance that all SCs subject to AMR have been identified.
   - For LR documentation, an applicant can apply some grouping convention but must describe the convention and it must be traceable to documentation retained on site.
   - On site, the applicant must maintain documentation of SCs subject to AMR which (1) Is sufficient to allow the Staff to audit SCs subject to aging management review and (2) Should identify each SC within the groupings shown in the LR submittal.
4. BGE's component level scoping process for systems appears to be completely consistent with the stated NRC position.
5. BGE's component level scoping process for structures is described in the IPA methodology which has been submitted and approved as meeting the requirements of 54.21(a)(2) of the LR Rule. The process uses a generic listing of structural component types to conduct the scoping process and identifies whether each structure contains one or more structural components of each structural component type. This component level scoping process for structures would also be consistent with the NRC's position provided that the concept of "lists to be maintained on site" is interpreted as described below.

Proposed Solution

"Lists of SCs subject to AMR to be maintained on site" would be interpreted as follows - :

1. The information to be maintained on site would consist of the list of structural component types subject to AMR and a technique, using site documentation practices, for generating the complete list of individual structural components if required.
2. The itemized, component-by-component list would only need to be produced if a sound technical reason exists for producing the list. Otherwise, the itemized list would not be produced or maintained.
3. For example, the component level scoping process for structures identifies that the auxiliary building has roof trusses as a structural component type which contributes to the intended functions of that structure. Site documentation includes plant layout drawings and architectural drawings for the Auxiliary Building which could be used to produce an itemized list of roof trusses if the technical need arises to do so. If the AMR reveals that there are no plausible aging mechanisms for the roof trusses, then no itemized list of these components would be produced. If plausible aging is identified but the

aging management practice consists of a biased sampling technique, no itemized listing would be produced. However, if a statistical sampling technique is chosen to inspect these trusses and a particular confidence level is targeted, one method to achieve such a confidence level would be to conduct a sample inspection of a certain percentage of the total population of roof trusses. In this case, an itemized listing would be technically necessary to carry out the proposed program and therefore, such a list would be produced.

Conclusion

Lists of system type components subject to AMR have already been produced by BGE based on existing component lists. These lists would be maintained in order to support the summary level list information contained in the LR Application. However, such component-by-component lists do not exist for structures (buildings) at CCNPP and the level of effort to produce an itemized listing of all structural components subject to AMR would be substantial. The interpretation of the NRC position on lists described in this paper allows BGE to focus its resources on producing lists only when such lists would serve a valid technical/safety purpose.