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7.1 Structures

7.1.1 Scoping

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:

- 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 sp...

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

In accordance with the IPA methodology, intended functions were identified for each structure. These results are presented in Table 7.1-1:

TABLE 7.1-1

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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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.

During the scoping process, structural components were identified for each structure within the scope of License Renewal. These structural components were grouped 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. Table 7.1-2 lists these component types and the structures to which they are applicable. Functions from Table 7.1-1 indicate which structural component contributes to the intended functions.

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 7.1-2

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)		1, 5	2		1, 2	1, 2
Columns	1, 5	1, 5	2, 4, 7			
Walls		1, 2, 4, 5, 6, 7	1, 2, 4, 7	1, 2, 4, 6, 7	2, 4	2, 4
Beams	1, 5	1, 5	2, 4			
Ground Floor Slabs/Equipment Pads		1, 5	1, 2	1, 2, 4, 6, 7		
Elevated Floor Slabs	1, 5	1, 2 , 5 ,7	1, 2	1, 2, 6, 7		
Roof Slabs		2, 4	2		2, 4	2, 4
Cast-In-Place Anchors/Embedments•	1, 5	1	1, 2, 6, 7	1, 2, 6, 7	1, 2, 4, 5	1, 2, 4
Ductbanks				1, 2		
Grout	1, 5	1, 5	1, 2	1, 2, 6, 7	1, 2, 4, 5	2
Concrete Blocks (Shielding)		2				
Removable Missile Shield	4					
Fluid Retaining Walls and Slabs		1	1, 2, 6	1, 2, 6, 7		
Masonry Block Walls		1, 2, 5, 6, 7				
Post-Installed Anchors•	1	1, 5	2, 5	4, 5	5	
Structural Steel						
Columns•	1,5	1, 5				
Beams•	1, 5	1, 5	1, 2	1, 2, 7	2, 4	2, 4
Baseplates•	1,5	1, 5	1, 5	1, 2, 4, 5, 7	2, 4	2, 4
Floor Framing•	1, 5	1, 5	1, 5	1, 5		
Roof Framing•		1, 4, 5	2		2, 4	2, 4
Roof Trusses•		1, 4, 5				
Bracing•	1, 5	1, 5	2, 5	4	5	
Platform Hangers•	1, 5	1, 5	5	5	5	

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TABLE 7.1-2 (Cont.)

STRUCTURAL COMPONENT TYPES REQUIRING AMR

	Containment	Auxiliary Building	Intake Structure	Turbine Building	No. 21 FOST Enclosure	No. 12 CST Enclosure
Structural Steel						
Decking•	1, 5	1, 5	2	1, 2, 7	2, 4	2, 4
Jet Impingement• Barriers		2		4		
Liners	3	3				
Floor Grating•	1, 5		5	5	5	
Checkered Plates•	1, 5		2			
Stairs and Ladders•			5	5	5	
Architectural Components						
Building Siding Clips•				2		
Fire Doors, Jambs, and Hardware•		7	2, 7	2, 6, 7		
Access Doors, Jambs, and Hardware•		2	2	2, 6, 7		
Caulking and Sealants		2, 6, 7	2, 6, 7	2, 6, 7	1, 2	1, 2
Coatings (including galvanizing)	1, 2, 3, 4, 5, 7					
Unique Components						
Concrete Basemat	1, 2, 3, 4, 5, 6, 7					
Concrete Dome	1, 2, 3, 4, 5, 7					
Concrete Containment Walls	1, 2, 3, 4, 5, 6, 7					
Primary/Secondary Shield Wall	1, 2, 4					
Refueling Pool Concrete	1, 6					
Refueling Pool Liner	3					
Post Tensioning System	1, 2, 3, 4					
Crane Girder•	5					

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TABLE 7.1-2 (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•	1, 5					
Maranite XL Board	7					
New Fuel Rack Assembly•		1				
Spent Fuel Storage Racks		1				
Monorail•		5				
Cask Handling Crane Rail/Supports•		1, 5				
Lead Brick Shielding		2				
Pipe Whip Restraints•		2				
Roll-Up Doors•		2				
Expansion Joints		2, 7				
Watertight Doors•		6, 7	6	2, 6, 7		
Sluice Gates•			1			
Anchor Brackets•					1	
System Type Components						
Electrical Penetrations (Non-EQ)	3					
Mechanical Penetrations	3					
Fuel Transfer Tube/ Bellows	3					
Personnel Airlocks	3, 7					
Equipment Hatch	3, 7					

* Indicates that component type is included under the heading "Steel Components" in the discussion addressing the results of the AMR and in Table 7.1-3.

7.1.2 Aging Management

The potential age-related degradation mechanisms (ARDMs) for structures are identified in Table 7.1-3. The table is divided into two parts, Structural Type Components and Systems Type Components, because the ARDMs differ 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 also identified in Table 7.1-3

The following paragraphs provide the demonstration for each group of components subject to an AMR that the effects of the plausible aging identified in Table 7.1-3 are adequately managed such that there will be reasonable assurance that the intended function will be maintained consistent with the current licensing basis (CLB) during the period of extended operations. Hereafter, discussion of Structures is 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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TABLE 7.1-3

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 Liner	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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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 the 10 foot elevation.

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.

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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.

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 Chemical Attack on Concrete - Aging Mechanisms

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 ($pH < 4.0$) 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, if contained 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 has not been verified, aggressive chemical attack is considered 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. Aggressive chemical attack of these components, if left unmanaged, could lead to degraded functions for structural and/or functional support, shelter/protection, or flooding protection.

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Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Aggressive Chemical Attack on Concrete - Methods to Manage Aging

The effects of aging will only occur if the acidic water comes in contact with the concrete. There are two distinct areas of concern: below grade concrete and concrete in contact with Chesapeake Bay water.

Below-grade concrete is exposed to the groundwater table. Degradation of the concrete would occur if the chemical composition of the groundwater is significantly aggressive (pH < 4.0). Groundwater samples can be tested to determine the present day chemical composition. The results can be compared to pre-construction chemistry to determine the significance of any changes that may have occurred. This determination will provide the basis for further aging management.

Concrete in contact with Chesapeake Bay water is subject to the varying chemistry of the bay which can have a significant chloride concentration. The aging effects manifest themselves in changes to the physical surface appearance of the concrete such as cracking, spalling, and strength loss. Thus, visual inspection of these concrete surface areas will detect the effects of aging caused by aggressive chemical attack. These effects occur slowly and can be detected through visual inspection before the effects of aging will impact the intended functions.

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Aggressive Chemical Attack on Concrete - Aging Management Programs

Groundwater pH was tested during initial plant construction and determined to be basic (pH = 7.5). Conditions that are conducive to changes in pH such as nearby heavy industry are not present at CCNPP. However, because the characteristics of ground water have not been verified, degradation due to aggressive chemical attack was assumed plausible. Degradation of the concrete would only occur if ground water chemical composition is significantly more aggressive (pH < 4.0) than it was found to be during pre-construction testing. To provide additional assurance that such conditions are not present, groundwater observation wells installed during initial plant construction will be used for the investigation of the ground water chemistry. Groundwater chemistry will be compared to pre-construction composition to verify that significant changes have not occurred and that the aging mechanism does not need further aging management.

The concrete in contact with Chesapeake Bay water is accessible and inspected during outages. The visual inspection records the condition of the concrete. This inspection serves as the means for discovery of any degradation that may be caused by aggressive chemical attack. Any degraded conditions such as cracking, spalling, and strength loss is reported for further evaluation of the components' ability to continue to perform its intended functions. Further monitoring or repairs is based on this determination.

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Aggressive Chemical Attack on Concrete - Aging Management Demonstration

Based on the factors presented above, the following conclusions can be reached with respect aggressive chemical attack on concrete for ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs:

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- Ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs provide functions for structural and/or functional support, shelter/protection, rated fire barrier, or flooding protection.
- Aggressive chemical attack on concrete was determined to be plausible for ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs.
- Aggressive chemical attack on concrete causes cracking, spalling, and strength loss.
- Aggressive chemical attack of below grade concrete will not occur if groundwater pH is > 4.0.
- Ground water chemistry will be tested to confirm that it is well above a pH of 4.0.
- The concrete in contact with Chesapeake Bay water is accessible for inspection during outages. The visual inspection is performed to discover any degradation that may be caused by aggressive chemical attack.
- Indications of aggressive chemical attack are evaluated to determine the components' ability to continue to perform its intended functions.
- Therefore, there is reasonable assurance that structural and/or functional support, shelter/protection, rated fire barrier, or flooding protection functions provided by ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs will be maintained, consistent with the CLB during the period of extended operations.

<u>Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Corrosion of Embedded Steel/rebar - Aging Mechanisms</u>

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.

Embedded steel/rebar is covered by concrete which prevents the steel/rebar from being in direct contact with fluids. Under certain circumstances, these component types could be subject to wet conditions where the water could be acidic. Concrete's high alkalinity provides a basic environment around embedded steel/rebar and protects them from corrosion. If the concrete's pH is lowered to 4.0 or less, corrosion may occur. A reduction in pH can be caused by the leaching of alkaline products through cracks, or by the entry of acidic fluids, or by carbonation. Chlorides also could be present in constituent materials of the original concrete mix (i.e., cement, aggregates, admixtures, and water), or they can be introduced environmentally. When moisture and oxygen are present, the presence of water-soluble chloride ions can accelerate corrosion. The severity of corrosion is influenced by the properties and type of cement and aggregates and the concrete moisture content.

At CCNPP, concrete mixes were used to minimize chlorides in the constituent material and the groundwater pH was determined to be 7.5 at original construction. Thus, the likelihood that corrosion of embedded steel/rebar is occurring is reduced. However, because the present day groundwater chemistry has not been verified, corrosion of embedded steel/rebar is considered plausible for below grade portions of concrete.

For the intake structure fluid retaining walls and slabs, since the Chesapeake Bay water contains chemicals and chloride ions that might attack the concrete, corrosion of embedded steel/rebar is plausible.

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Corrosion of embedded steel/rebar results in corrosion products that 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. Corrosion of embedded steel/rebar, if left unmanaged, could lead to degraded functions for structural and/or functional support, shelter/protection, or flooding protection.

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Corrosion of Embedded Steel/rebar - Methods to Manage Aging

The effects of aging will only occur if the acidic water comes in contact with the concrete and is able to penetrate the concrete through reduction of the concrete's alkalinity or cracks in the concrete which penetrate to the embedded steel/rebar. There are two distinct areas of concern: below grade concrete and concrete in contact with Chesapeake Bay water.

Below-grade concrete is exposed to the groundwater table. Degradation of the concrete would occur if the chemical composition of the groundwater is significantly aggressive ($pH < 4.0$). Groundwater samples can be tested to determine the present day chemical composition. The results can be compared to pre-construction chemistry to determine the significance of any changes that may have occurred. This determination will provide the basis for further aging management.

Concrete in contact with Chesapeake Bay water is subjected to the varying chemistry of the bay which can have a significant chloride concentration. The aging effects manifest themselves in changes to the physical surface appearance of the concrete such as deterioration of concrete from a series of hairline cracking, rust staining, spalling, and more severe cracking. Thus, visual inspection of these concrete surface areas will detect the effects of aging caused by corrosion of embedded steel/rebar before the effects of aging will impact the intended functions.

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Corrosion of Embedded Steel/rebar - Aging Management Programs

Groundwater pH was tested during initial plant construction and determined to be basic ($pH = 7.5$). Conditions that are conducive to changes in pH such as nearby heavy industry are not present at CCNPP. However, because the characteristics of ground water have not been verified, degradation due to corrosion of embedded steel/rebar was assumed plausible. Degradation of the concrete would only occur if ground water chemical composition is significantly more aggressive ($pH < 4.0$) than it was found to be during pre-construction testing. To provide additional assurance that such conditions are not present, groundwater observation wells installed during initial plant construction will be used for the investigation of the ground water chemistry. Ground water chemistry will be compared to pre-construction composition to verify that significant changes have not occurred and that the aging mechanism does not need further aging management.

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The concrete in contact with Chesapeake Bay water is accessible and inspected during outages. The visual inspection records the condition of the concrete. This inspection serves as the means for discovery of any degradation that may be caused by corrosion of embedded steel/rebar. Any degraded conditions such as deterioration of concrete from a series of hairline cracking, rust staining, spalling, and more severe cracking is reported for further evaluation of the components' ability to continue to perform its intended functions. Further monitoring or repairs is based on this determination.

Ground Floor/Slabs, Basemats, Foundations, and Walls (below grade portions only); Intake Structure Fluid Retaining Walls and Slabs - Corrosion of Embedded Steel/rebar - Aging Management Demonstration

Based on the factors presented above, the following conclusions can be reached with respect to corrosion of embedded steel/rebar for ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs:

- Ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs provide functions for structural and/or functional support, shelter/protection, or flooding protection.
- Corrosion of embedded steel/rebar in concrete was determined to be plausible for ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs.
- Corrosion of embedded steel/rebar in concrete causes deterioration of concrete from a series of hairline cracking, rust staining, spalling, and more severe cracking.
- Corrosion of embedded steel/rebar in below grade concrete will not occur if groundwater pH is > 4.0.
- Ground water chemistry will be tested to confirm that it is well above a pH of 4.0.
- The concrete in contact with Chesapeake Bay water is accessible for inspection during outages. The visual inspection is performed to discover any degradation that may be caused by corrosion of embedded steel/rebar.
- Indications of corrosion of embedded steel/rebar are evaluated to determine the components' ability to continue to perform its intended functions.
- Therefore, there is reasonable assurance that structural and/or functional support, shelter/protection, or flooding protection functions provided by ground floor/slabs, basemats, foundations, and walls (below grade portions only); intake structure fluid retaining walls and slabs will be maintained, consistent with the CLB during the period of extended operations.

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

Steel Components - Corrosion of Steel - Aging Mechanisms

Corrosion of Steel was determined to be plausible for steel components (items marked with an asterisk in Table 7.1-2).

These steel components 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.

Continued long term corrosion can reduce steel thickness which compromises the structural capability of the steel components. Corrosion of steel, if left unmanaged, could lead to degraded functions for structural and/or functional support, shelter/protection, missile barrier, rated fire barrier, or flooding protection.

Steel Components - Corrosion of Steel - Methods to Manage Aging

All exposed steel surfaces were coated with paint. Coating serves as a protective layer, preventing moisture and oxygen from directly contacting the steel surfaces, and thus mitigating the effects of the ARDM by reducing the rate of corrosion. This rate of corrosion depends on environment and the condition of the coating. Only approved coatings are used for specific applications. Surface cleaning and preparation are specified to maximize the coating life.

Since steel surfaces are subject to corrosion, they were coated with paint during construction so corrosion of steel is minimized. Steel will only corrode if the coating breaks down and allows moisture and oxygen to come in contact with the exposed steel. Visual observation serves as a discovery method to identify any corrosion that may be occurring due to a degraded protective coating. Coatings degrade slowly over a long period of time. Coatings which are blistered, chalky, or showing rust stains have degraded to the point where the steel could be exposed to moisture and oxygen. Visual observation of the coatings' condition is an effective method to identify these conditions and to ensure that corrosion has not affected the intended function of the structural steel.

Steel Components - Corrosion of Steel - Aging Management Program

During original construction, structural steel was prepared and painted in accordance with construction specifications. Since construction the site protective coatings program ensures that the proper coatings are provided and applied to prepared surfaces in a correct manner to maximize the coatings' service life.

Steel components are located in both accessible and nonaccessible areas. The aging management programs differ based on the location. Discovery of any degradation of the protective coating in accessible areas is accomplished by a number of activities, including periodic documented inspections by assigned systems engineers. These walkdowns, conducted in accordance with a Plant Engineering Guideline entitled "System Walkdowns," are adequate aging management activities for the following reasons:

- Walkdowns are conducted at periodic intervals, normally monthly or as negotiated with each system engineer's supervisor.

- Walkdowns are performed by an assigned system engineer who is familiar with the interface of his system to the surrounding structure. Any signs of corrosion would be detected by this individual.
- To assist the system engineer in detecting such conditions, the "System Walkdown" guideline contains a checklist on which to document conditions observed during the walkdown.
- The Plant Engineering Guideline on System Walkdowns requires that any unusual condition observed during the system engineers walkdown be recorded on the walkdown sheet and assistance obtained from design engineering in evaluating the impact of the unusual condition. Conditions that warrant further action are documented on an issue report and the site corrective action program tracks the status of corrective actions.

Evaluation of degraded conditions, corrective action, and follow-up activities are controlled by existing plant programs for maintaining protective coatings. By maintaining the coatings of the external surfaces of the structural steel, corrosion of structural steel will be prevented.

Coatings which are determined not to be effective in preventing corrosion of the structural steel are replaced at the earliest opportunity. Since the degradation of the underlying steel is slow and localized to the surface, it is not expected that the intended function of the structural steel will be effected before the repair of the coating.

The aging of structural steel located in inaccessible areas is not expected to be different from that of structural steel in accessible areas. To provide additional assurance that deterioration of structural steel protective coatings are not progressing differently, inaccessible structural steel locations will be subject to an age-related degradation inspection in accordance with the IPA methodology described in Section 2.0. The age-related degradation inspection will include the following:

- Identification of non-accessible locations
- Selection of representative structural steel components for inspection
- Development of an inspection sample size
- Use of appropriate inspection techniques
- Requirements for reporting of results and corrective actions if aging concerns are identified

Steel Components - Corrosion of Steel - Aging Management Demonstration

Based on the factors presented above, the following conclusions can be reached with respect to corrosion of steel components:

- Steel components provide functions for structural and/or functional support, shelter/protection, missile barrier, rated fire barrier, or flooding protection.
- Corrosion was determined to be plausible for steel components.
- Steel corrodes in the presence of moisture and oxygen. Coatings mitigate the effects of corrosion by providing a protective layer, preventing moisture and oxygen from contacting the steel.
- Coatings were specified during original construction and are maintained through the site coatings program.
- Discovery of any degradation of the protective coating in accessible areas is accomplished by a number of activities, including periodic documented inspections by assigned system engineers.

- Evaluation of degraded conditions, corrective action, and follow-up activities are controlled by existing plant programs for maintaining protective coatings.
- Therefore, there is reasonable assurance that structural and/or functional support, shelter/protection, rated fire barrier, or flooding protection functions provided by steel components will be maintained, consistent with the CLB during the period of extended operations.

The results of the aging evaluation on Unique/Architectural type components are presented below:

Caulking and Sealants, and Expansion Joints - Weathering - Aging Mechanisms

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 these component types since they are in an environment exposed to ambient conditions.

The effects of weathering on these materials are exhibited by a decrease in elasticity, an increase in hardness, and shrinkage. Weathering of these components, if left unmanaged, could lead to degraded functions for shelter/protection including HELB, rated fire barrier, or flooding protection.

Caulking and Sealants, and Expansion Joints - Weathering - Methods to Manage Aging

The effects of weathering on caulking and sealants, and expansion joints can be detected by periodic inspection. The conditions to observe that are caused by weathering are shrinkage and hardness of the caulking and sealants, and expansion joints. Visual observation will detect shrinkage and checking for hardness by hand will detect hardness before loss of intended function would occur.

Caulking and Sealants, and Expansion Joints - Weathering - Aging Management Program

Visual observation for shrinkage and checking for hardness by hand is performed through condition monitoring activities. Periodic condition monitoring activities are incorporated into the site PM program. The PM program is scheduled through the site database maintenance module which ensures the condition monitoring activities are performed on a periodic basis. The PM program is controlled by procedure to ensure that the proper priorities are identified for timely corrective actions and root cause analysis. The site database allows for correlation of degraded conditions across components to provide indication for when the periodicity may require changes. The proper periodicity ensures that condition monitoring will detect degradation of caulking and sealants, and expansion joints and allow for correction before loss of intended function will occur.

Site PM activities exist for Appendix R rated fire barriers which meet the requirements of 10 CFR 50.48. The inspections will detect shrinkage and hardness of the caulking and sealants, and expansion joints. Any shrinkage/ hardness that would affect the components' ability to perform its intended function is considered unacceptable and requires repair or replacement.

Similar to the existing site PMs, a new PM activity will be created for all non Appendix R caulking and sealants, and expansion joints that are within the scope of License Renewal. Similar inspections will detect

shrinkage/ hardness of the caulking and sealants, and expansion joints. Any shrinkage/ hardness that would affect the components' ability to perform its intended function is considered unacceptable and requires repair or replacement.

Caulking and Sealants, and Expansion Joints - Weathering - Aging Management Demonstration

Based on the factors presented above, the following conclusions can be reached with respect to weathering of caulking and sealants, and expansion joints:

- Caulking and sealants, and expansion joints provide the functions of safety related equipment shelter/protection including HELB, rated fire barrier, or flooding protection.
- Weathering was determined to be plausible for caulking and sealants, and expansion joints.
- Weathering causes a decrease in elasticity, an increase in hardness, and shrinkage which can lead to a loss of shelter/protection, rated fire barrier function, or flooding protection.
- The existing PM activities and the new PM activities described above will detect shrinkage and hardness.
- Any shrinkage/ hardness that would affect the components' ability to perform its intended function is considered unacceptable and requires repair or replacement.
- Repair or replacement, will occur before loss of intended function will occur.
- Therefore, there is reasonable assurance that the shelter/protection, rated fire barrier, or flooding protection functions provided by caulking and sealants, and expansion joints will be maintained, consistent with the CLB, during the period of extended operations.

The following will be included later:

- ***Liners - Corrosion of liner***
- ***Post Tensioning System - Corrosion of Tendons***
- ***Post Tensioning System - Prestress Losses***
- ***Non-EQ Electrical/Mechanical Penetrations, Personnel Airlocks, Equipment Hatch - General corrosion/oxidation***

Conclusion

The programs discussed for structures are listed in the following table. These programs are administratively controlled by a formal review and approval process. As demonstrated above, these programs will be manage the aging mechanisms and their effects such that the intended functions of the structures will be maintained, consistent with the CLB, during the period of extended operations.

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TABLE 7.1-4

LIST OF AGING MANAGEMENT PROGRAMS FOR STRUCTURES

Program	Credited as:
CCNPP PM Program MN-1-103	Administrative controls for periodic inspection which manage the effects of aggressive chemical attack and corrosion of embedded steel/rebar for intake structure fluid retaining walls.
New program to investigate groundwater chemistry	Management of the effects of aggressive chemical attack and corrosion of embedded steel/rebar for below grade concrete.
Plant Engineering Guideline on System Walkdowns	Administrative controls for periodic inspection which manage the effects of corrosion of steel for accessible steel components.
CCNPP's Protective Coating and Painting Program MN-3-100	Administrative controls for periodic inspection which mitigate and manage the effects of corrosion of steel for accessible steel components.
Age-related degradation inspection (ARDI) program (new) to investigate inaccessible steel locations	Management of the effects of corrosion of steel for inaccessible steel components.
CCNPP PM Program MN-1-103	Administrative controls for periodic inspection which manage the effects of weathering for Appendix R caulking, sealants, and expansion joints.
CCNPP PM Program MN-1-103 (new activities)	Administrative controls for periodic inspection which manage the effects of weathering for non-Appendix R caulking, sealants, and expansion joints.

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TABLE 7.1-5

LIST OF REFERENCES FOR STRUCTURES

1. CCNPP Updated Final Safety Analysis Report, Revision 19.

2. "Aging Management Review Report for the Containment System (059)," Revision 0, July 28, 1995.

3. "Component and Program Evaluation of Four Structures - Intake Structure, Turbine Building, FOST Enclosure, CST Enclosure - Calvert Cliffs Nuclear Power Plant," Revision 0, March 29, 1995.

4. "Component Evaluation and Program Evaluation Results for the Containment System," Revision 1, February 22, 1994.

5. "Component Evaluation and Program Evaluation Results for the Auxiliary Building ," Revision 0, July 28, 1995.

6. "Examination of the Unit 1 Containment Structure - Calvert Cliffs Nuclear Power Plant," August 1992.

7. "Examination of Condensate Storage Tank #12 Enclosure - Calvert Cliffs Nuclear Power Plant," September 21, 1994.

8. "Examination of Fuel Oil Storage Tank #21 Enclosure - Calvert Cliffs Nuclear Power Plant," September 21, 1994.

9. "Examination of Intake Structure - Calvert Cliffs Nuclear Power Plant," October 24, 1994.

10. "Examination of Auxiliary Feedwater Pump Rooms - Calvert Cliffs Nuclear Power Plant," October 27, 1994.