3.6 STRUCTURES AND STRUCTURAL COMPONENTS

Structures and their structural components and commodities that are within the scope of license renewal and subject to aging management reviews are discussed in Section 2.4 and summarized in Tables 3.6-2 through 3.6-20.

Determination of the aging effects applicable to structures and their structural components and commodities begins with identification of the aging effects defined in industry literature. From the set of aging effects, the component and commodity materials and operating environments define the aging effects for each structural component or commodity that is subject to an aging management review. These aging effects are validated by a review of industry and Turkey Point Units 3 and 4 operating experiences to provide reasonable assurance that the full set of aging effects are established for the aging management review.

Structural components inaccessible for inspection were evaluated for potential aging effects based on their environment as part of the aging management review. Several structural components that are inaccessible for visual inspection require aging management at Turkey Point. Examples include buried concrete, embedded steel, and structural components blocked by installed equipment or structures. Structural components inaccessible for inspection are managed by inspecting accessible structures with similar materials and environments for aging effects that may be indicative of aging effects for inaccessible structural components. The programs credited for managing aging effects of inaccessible structural components are the ASME Section XI, Subsection IWE Inservice Inspection Program and the Systems and Structures Monitoring Program. These programs are discussed in Appendix B.

3.6.1 CONTAINMENTS

The Westinghouse Generic Topical Report, WCAP-14756, "Aging Management Evaluation for Pressurized Water Reactor Containment Structure," is not credited and is not incorporated by reference in this Application.

The Containments are divided into two structural classifications, Containment structure, and Containment internal structural components. The components of the structural classifications are grouped by material or function. The Containment structure component groupings are concrete, steel, and post-tensioning system. The Containment internal structural components groupings are concrete and steel.

3.6.1.1 CONTAINMENT STRUCTURE CONCRETE COMPONENTS

The Containment structure concrete components are:

- dome
- cylinder wall
- floor
- foundation mat

3.6.1.1.1 MATERIALS AND ENVIRONMENT

The Containment structure concrete components were designed and constructed in accordance with ACI and American Society for Testing and Materials (ASTM) standards to provide good quality, dense, low permeability concrete. The codes and standards used for design and fabrication of the Containment structure concrete components are provided in Turkey Point UFSAR Subsections 5.1.2 and 5.1.6.

Containment structure concrete components are exposed to several different environments depending on their location. Below grade (buried) Containment structure concrete components can be either above or below the groundwater elevation. Containment structure concrete components that are below grade and above groundwater are exposed to soil/fill. Containment structure concrete components that are below groundwater are exposed to soil/fill and groundwater. The groundwater chemistry is relevant in the determination of the degradation of below groundwater Containment structure concrete components. Based on a review of the Turkey Point Final Environmental Statement [Reference 3.6-1], the groundwater parameters for chlorides and sulfates exceed the threshold limits where degradation may occur. Above grade external surfaces of the Containment structure are exposed to indoor – not air conditioned and outdoor environments. Internal components of the Containment structure are exposed to the Containment air environment (see Table 3.0-2).

3.6.1.1.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of the intended function(s) for Containment structure concrete components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Loss of material is manifested in Containment structure concrete components as scaling, spalling, pitting, and erosion. Aging mechanisms that can lead to loss of material are freeze-thaw, abrasion and cavitation, elevated temperature, aggressive chemical attack, and corrosion of reinforcing and embedded steel.

Freeze-thaw is considered an aging mechanism for concrete structural components that are exposed to severe weather conditions of numerous freeze-thaw cycles with significant amounts of winter rainfall. Turkey Point is located in a subtropical climate with long, warm summers accompanied by abundant rainfall and mild, dry winters with negligible freeze-thaw cycles. Therefore, freeze-thaw is not an aging mechanism that can lead to loss of material for Containment structure concrete components.

Abrasion and cavitation is an aging mechanism that occurs only in concrete structures that are continually exposed to flowing water. The Intake Structure concrete components located below the intake canal water level and the concrete intake cooling water piping are the only concrete components exposed to flowing water. Therefore, abrasion and cavitation is not an aging mechanism that can lead to loss of material for Containment structure concrete components.

Elevated temperature was evaluated as an aging mechanism for Containment structure concrete components. The concrete around hot piping penetrations is subject to extended local heatup. The penetrations were designed and constructed to maintain concrete components below the degradation threshold and localized temperature limits of the ACI standards without forced ventilation. No other Containment structure concrete components are exposed to elevated temperature.

Therefore, elevated temperature is not an aging mechanism that can lead to loss of material for Containment structure concrete components.

Aggressive chemical attack and corrosion of reinforcing and embedded steel are aging mechanisms for Containment structure concrete components exposed to groundwater. As discussed in Subsection 2.4.1.1, design features such as waterproofing membranes and water stops are utilized underneath the foundation mat and outside the lower portions of the Containment structure wall. In addition, a cathodic protection system is provided as a design feature to control galvanic corrosion of the reinforcing and embedded steel as a preventive measure. However, the waterproofing membranes, water stops, and cathodic protection system are not credited in the determination of aging effects requiring management.

Based on the above, loss of material due to aggressive chemical attack and corrosion of reinforcing and embedded steel is an aging effect requiring management for Containment structure concrete components below groundwater elevation.

CRACKING

Cracking is manifested in Containment structure concrete components as complete or incomplete separation of the concrete into two or more parts. Aging mechanisms that can lead to cracking are freeze-thaw, reactions with aggregates, shrinkage, settlement, fatigue, and elevated temperature.

As discussed previously, freeze-thaw is not an aging mechanism that can lead to cracking for Containment structure concrete components.

Turkey Point concrete components were constructed using non-reactive aggregates whose acceptability was based on established industry standards and ASTM tests. Therefore, reaction with aggregates is not an aging mechanism that can lead to cracking for Containment structure concrete components.

When concrete is exposed to air, large portions of the free water evaporate, causing shrinkage. At Turkey Point, the initial concrete water content was kept low, low slump concrete was used, and adequate steel reinforcement was provided, which all minimize shrinkage. Based on industry information, 100% of shrinkage occurs within 20 years. Turkey Point concrete structures and concrete components were constructed more than 20 years ago. Therefore, concrete shrinkage is not an aging mechanism that can lead to cracking for Containment structure concrete components.

Settlement is based directly on the physical properties of a structure's foundation material. The most pronounced settlement is evidenced in the first several months after construction. Turkey Point concrete structures are founded on fossiliferous limestone bedrock (Miami Oolite) with crushed limestone fill. This foundation material is suitable for foundation systems with no significant structural settlement expected. Therefore, settlement is not an aging mechanism that can lead to cracking for Containment structure concrete components.

Fatigue is a progressive degradation problem for materials subjected to cyclic application of loads that are less than the maximum allowable static loads. Turkey Point concrete components are designed in accordance with ACI standards and have good low-cycle fatigue properties. Although some concrete components are subject to high cycles of low-level repeated load, these components were designed in accordance with ACI standards, which limit the maximum design stress to less than 50% of the static stress of the concrete. The concrete fatigue strength is about 55% of its static strength at extremely high cycles ($>10^7$ cycles) of loading. Therefore, fatigue is not an aging mechanism that can lead to cracking for Containment structure concrete components.

As discussed previously, the Containment structure concrete components do not exceed established threshold limits for degradation due to elevated temperature. Therefore, elevated temperature is not an aging mechanism that can lead to cracking.

Based on the above, cracking is not an aging effect requiring management for containment structure concrete components.

<u>CHANGE IN MATERIAL PROPERTIES</u>

Change in material properties is manifested in concrete as increased permeability, increased porosity, reduction in pH, reduction in tensile strength, reduction in compressive strength, reduction in modulus of elasticity, and reduction in bond strength. Aging mechanisms that can lead to a change in material properties are leaching, creep, elevated temperature, irradiation embrittlement, and aggressive chemical attack.

Leaching of calcium hydroxide is observed on concrete that is alternately wetted and dried. White deposits that are left on the surface of the concrete are a solution of water, free lime from the concrete, and carbon dioxide that is readily seen on the surface of the concrete. Turkey Point concrete structures and concrete components are constructed of dense, well-cured concrete with an amount of cement suitable for strength development, and achievement of a water-to-cement ratio that is characteristic of concrete having low permeability. This is consistent with the guidance provided by the ACI, and when implemented, degradation caused by leaching of calcium hydroxide is not significant. Therefore, leaching is not an aging mechanism that can lead to change in material properties for Containment structure concrete components.

Creep is significant when new concrete is subjected to load and decreases exponentially with time; and any degradation is noticeable in the first few years. All reinforced concrete components were designed based on the ACI working stress design method. Creep in all concrete components is minimal because of low compressive stresses in concrete and the use of high strength concrete. In addition, creep proceeds at a decreasing rate with age, 96% of creep has occurred within 30 years; and therefore, concrete creep is not an aging mechanism that can lead to change in material properties for Containment structure concrete components.

As discussed previously, the Containment structure concrete components do not exceed established threshold limits for degradation due to elevated temperature. Therefore, elevated temperature is not an aging mechanism that can lead to change in material properties for Containment structure concrete components.

Irradiation embrittlement was evaluated as an aging mechanism that could lead to change in material properties. Shielding from the water in the reactor core and the reactor vessel reduces the neutron flux, resulting in levels of accumulated exposure that are far below the levels necessary to cause degradation. The maximum gamma dose evaluated through the period of extended operation is below the dose required for radiation degradation. Therefore, irradiation embrittlement is not an aging mechanism that can lead to change in material properties for Containment structure concrete components.

As discussed above, aggressive chemical attack is an aging mechanism that can lead to change in material properties for concrete components below groundwater elevation.

Based on the above, change in material properties due to aggressive chemical attack is an aging effect requiring management for Containment structure concrete components below groundwater elevation.

3.6.1.1.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to Containment structural concrete components includes the following:

- NRC Information Notice 97-11, "Cement Erosion from Containment Subfoundations at Nuclear Power Plants"
- NRC Information Notice 98-26, "Settlement Monitoring and Inspection of Plant Structures Affected by Degradation of Porous Concrete Subfoundations"
- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"
- NUREG/CR-4652, "Concrete Component Aging and its Significance Relative to Life Extension of Nuclear Power Plants"
- NUREG/CR-6598, "An Investigation of Tendon Sheathing Filler Migration into Concrete"
- NUREG/CP-0100, Prasad, N., et al., "Concrete Degradation Monitoring and Evaluation," Proceedings of the International Nuclear Power Plant Aging Symposium, August 30 – September 1, 1998

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.1.1.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of Containment structure concrete component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.1.1.2.

3.6.1.1.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.1.1.2. Table 3.6-2 contains the results of the aging management review for the Containments, and summarizes the aging effects requiring management for Containment structure concrete components.

The aging effects requiring management are adequately managed by the following program:

- Systems and Structures Monitoring Program

Based on the evaluation provided in Appendix B for the program above, aging effects are adequately managed so that the intended functions of the Containment structure concrete components listed in Table 3.6-2 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.1.2 CONTAINMENT STRUCTURE STEEL COMPONENTS

The Containment structure steel components are:

- liners (including the liner plate, anchors/embedments/attachments, leak chase channels, and moisture barriers)
- penetrations [including mechanical piping, mechanical ventilation, and steel portions (pressure boundary) of the electrical penetration assemblies]
- airlocks and hatches (personnel hatch, equipment hatch, escape hatch, including seals and gaskets)
- fuel transfer tube blind flanges (Note: The fuel transfer tubes, penetration sleeves, and gate valves are addressed in Subsection 3.6.2.2.)

3.6.1.2.1 MATERIALS AND ENVIRONMENT

The Containment structure steel components were designed and constructed in accordance with ASME Section III – 1965 for the pressure boundary, and American Institute of Steel Construction (AISC), Manual of Steel Construction, for structural steel. The codes and standards used for design and fabrication of the Containment structure steel components are provided in Turkey Point UFSAR Subsections 5.1.2 and 5.1.6.

The gaskets, seals, and moisture barriers that protect the Containment structure steel components are elastomers.

The Containment structure steel components are exposed to containment air, indoor – not air conditioned, outdoor, and embedded/encased environments and potential borated water leaks (see Table 3.0-2).

3.6.1.2.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of the intended function(s) for Containment structure steel components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Aging mechanisms that can lead to loss of material are material compatibility, mechanical wear, corrosion, and aggressive chemical attack.

For electrical penetrations, material compatibility tests have been conducted to determine the effects of polymer outgassing on metal corrosion. The test results indicate that the metals and alloys had insignificant amounts of corrosion when exposed to outgasses. The testing conditions are significantly more severe than those experienced by the materials in service in the Turkey Point Containment structures. Therefore, material compatibility is not an aging mechanism that can lead to loss of material for Containment structure steel components.

Mechanical wear can occur at the blind flange closure, located at the inside containment end of each fuel transfer tube that functions as part of the containment system pressure boundary. The moving parts may experience some mechanical wear over time; however, any wear that would interfere with the capability of the blind flange to be removed and replaced would be detected during normal refueling operations and would be addressed in the corrective action program. The Turkey Point airlocks and hatches are opened by mechanical means. The airlocks are designed with an interlock system that ensures the containment pressure boundary is maintained when the airlocks are used for access during reactor operation. The interlock system permits only one of the two airlock doors on each airlock to be open at one time. There are no other structural component metal surfaces in contact with and moved frequently against each other. Therefore, mechanical wear is not an aging mechanism that can lead to loss of material for Containment structure steel components.

Loss of material in steel may be caused by corrosion. This can be seen as material dissolution, corrosion product buildup, and pitting. It can be uniform or localized. Therefore, corrosion is an aging mechanisms that can lead to loss of material in Containment structure steel components at Turkey Point.

Aggressive chemical attack due to boric acid is an aging mechanism for Containment structure steel components. This form of corrosion is typically localized and is a result of leakage from the Reactor Coolant and other borated systems that can concentrate boric acid and lead to significant material loss of carbon steel components. Although this type of corrosion is event driven (boric acid leak), boric acid corrosion was evaluated as an aging mechanism that can lead to loss of material for Containment structure steel components.

Based on the above, loss of material due to corrosion and aggressive chemical attack, is an aging effect requiring management for Containment structure steel components.

CRACKING

Aging mechanisms that can lead to cracking of Containment structural steel components are stress corrosion and fatigue.

Stress corrosion cracking is an age-related degradation mechanism that affects stainless steels but becomes significant only if tensile stresses and a corrosive environment exist. The stresses may be either applied (external) or residual (internal). The stress corrosion cracks themselves may be either transgranular or intergranular, depending upon the metal and the corrosive agent. As is normal in all cracking, the cracks are perpendicular to the tensile stress. Usually there is little or no obvious visual evidence of corrosion. Stress corrosion cracking is not applicable for the carbon-steel liner plate and, therefore, is not an aging mechanism that can lead to cracking for Containment structure steel components.

Fatigue is a progressive degradation problem for materials subjected to cyclic application of loads that are less than the maximum allowable static loads. For steel components, fatigue is the cumulative effect of microstructural localized plastic deformation in the material section that results each time a stress cycle of sufficient magnitude occurs. Cracking due to fatigue of the liner plate and penetrations is a Time-Limited Aging Analysis and is discussed in Section 4.6.

Based on the above, cracking is not an aging effect requiring management for Containment structure steel components.

CHANGE IN MATERIAL PROPERTIES

Change in material properties is manifested in Containment structure steel components as a reduction or increase in yield strength, reduction in modulus of elasticity, reduction in ultimate tensile ductility, and an increase in ductile to brittle transition temperature. Aging mechanisms that can lead to change in material properties are elevated temperature, irradiation embrittlement, and embrittlement and permanent set of elastomers.

Elevated temperature was evaluated as an aging mechanism. For Containment structure steel components, a temperature of 700ºF must be reached before significant reductions in the yield strength and modulus of elasticity occur. Since the operating temperatures of the Containment structure steel components are below the threshold temperature, the temperature at which structural integrity of the steel would begin to be affected will not be reached. Therefore, elevated temperature is not an aging mechanism that can lead to change in material properties for Containment structure steel components.

As discussed in Subsection 3.6.1.1.2, irradiation embrittlement was evaluated as an aging mechanism that could lead to change in material properties. Shielding from the water in the reactor core and the reactor vessel reduces the neutron flux, resulting in levels of accumulated exposure that are far below the degradation threshold. Therefore, irradiation embrittlement is not an aging mechanism that can lead to change in material properties for Containment structure steel components.

Elastomers are used as gaskets and seals for airlocks and hatches and as moisture barriers for the Containment liner. Embrittlement and permanent set of elastomers can lead to change in material properties, which can result in loss of pressure retention capability.

Based on the above, change in material properties due to embrittlement and permanent set of elastomers associated with Containment structure steel components is an aging effect requiring management.

3.6.1.2.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to Containment structural steel components includes the following:

- NRC Bulletin 82-02, "Degradation of Threaded Fasteners in the Reactor Coolant Pressure Boundary of PWR Plants"
- NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to the Reactor Coolant System"
- NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification"
- NRC Generic Letter 80-08, "Examination of Containment Liner Penetration Welds"
- NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants"
- NRC Generic Letter 98-04, "Potential Degradation of the Emergency Core Cooling System and Containment Spray System after a Loss of Coolant Accident because of Construction and Protective Coating Deficiencies and Foreign Material in the Containment"
- NRC Information Notice 86-99 and Information Notice 86-99 Supplement1, "Degradation of Steel Containments"
- NRC Information Notice 88-80, "Unexpected Piping Movement Attributed to Thermal Stratification"
- NRC Information Notice 89-79, "Degraded Coatings and Corrosion of Steel Containment Vessels"
- NRC Information Notice 93-25, "Electrical Penetration Assembly Degradation"
- NRC Information Notice 97-10, "Liner Plate Corrosion in Concrete Containments"
- NRC Information Notice 97-13, "Deficient Conditions Associated with Protective Coatings at Nuclear Power Plants"

- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.1.2.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of Containment structure steel component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.1.2.2.

3.6.1.2.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.1.2.2. Table 3.6-2 contains the results of the aging management review for the Containments and summarizes the aging effects requiring management for Containment structure steel components.

The aging effects requiring management are adequately managed by the following programs:

- ASME Section XI, Subsection IWE Inservice Inspection Program
- Boric Acid Wastage Surveillance Program

Based on the evaluations provided in Appendix B for the programs listed above, aging effects are adequately managed so that that the intended functions of the Containment structure steel components listed in Table 3.6-2 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.1.3 CONTAINMENT STRUCTURE POST - TENSIONING SYSTEM

The Containment structure post-tensioning system components are:

- tendon wires
- tendon anchorage

3.6.1.3.1 MATERIALS AND ENVIRONMENT

The codes and standards used for design and fabrication of the Containment structure post-tensioning system are provided in UFSAR Section 5.0 and Appendices 5A and 5B. The post-tensioning system is described in UFSAR Section 5.1.

Each tendon is housed in spirally wrapped, corrugated, thin wall sheathing and capped at each end with a sheathing filler cap. After fabrication, the tendon is shop dipped in grease. The tendon sheathing provides the channel in the concrete through which the tendon is pulled, and contains the tendon sheathing filler material (grease). The tendon anchorages and tendon wires are contained in the sheathing filler material (grease).

3.6.1.3.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of intended function(s) for the Containment post-tensioning system components are loss of material and loss of prestress. Each is discussed below.

LOSS OF MATERIAL

Loss of material may be caused by corrosion.

The effects of corrosion must be considered for both the tendon wires within the grease-filled conduits and for the anchorages providing the tendon terminations. Stressed components of the Containment structure post-tensioning system are normally well protected against corrosion. The tendon and anchorages are enclosed with tendon sheathing and end caps that are filled with grease.

Based on the above, loss of material due to corrosion is an aging mechanism requiring management for Containment structure post-tensioning system components.

LOSS OF PRESTRESS

Aging mechanisms that can lead to loss of prestress are: elevated temperatures, irradiation, stress relaxation of the prestressing wire, shrinkage, creep or elastic deformation of the concrete, anchorage seating losses, and tendon friction. Loss of prestress of the Containment structure post-tensioning system is a Time-Limited Aging Analysis and is discussed in Section 4.5.

3.6.1.3.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to Containment structure post-tensioning system components includes the following:

- NRC Information Notice 85-10, "Post-Tensioned Containment Tendon Anchor Head Failure"
- NRC Information Notice 91-80, "Failure of Anchor Head Threads on Post-Tensioning System During Surveillance Inspection"
- NRC Information Notice 99-10, "Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments"
- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"
- NUREG/CR-0092, "Corrosion of Steel Tendons in Concrete Pressure Vessels, Review of Recent Literature and Experimental Investigations"
- NUREG/CR-2719, "Evaluation of Inservice Inspections of Greased Prestressing Tendons"
- NUREG/CR-6598, "An Investigation of Tendon Sheathing Filler Migration into Concrete"

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.1.3.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of Containment structure post-tensioning system component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.1.3.2.

3.6.1.3.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.1.3.2. Table 3.6-2 contains the results of the aging management review for the Containments and summarizes the aging effects requiring management for Containment structure post-tensioning system components.

The aging effects requiring management are adequately managed by the following program:

- ASME Section XI, Subsection IWL Inservice Inspection Program

Based on the evaluation provided in Appendix B for the program above, aging effects are adequately managed so that that the intended functions for Containment structure post-tensioning system components listed in Table 3.6-2 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.1.4 CONTAINMENT INTERNAL STRUCTURAL CONCRETE COMPONENTS

The Containment internal structural concrete components are:

- reinforced concrete primary shield walls
- reinforced concrete secondary shield walls
- reinforced concrete upper secondary compartment walls (steam generator and pressurizer cubicles)
- reinforced concrete refueling cavity walls
- reinforced concrete containment sumps
- reinforced concrete equipment pads
- reinforced concrete missile shields
- reinforced concrete beams, floors, mats, and walls
- reinforced concrete curbs

3.6.1.4.1 MATERIALS AND ENVIRONMENT

The Containment internal structural concrete components were designed and constructed in accordance with ACI and ASTM standards to provide good quality, dense, low permeability concrete. The codes and standards used for design and fabrication of the Containment internal structural concrete components are provided in Turkey Point UFSAR Subsections 5.1.2 and 5.1.6.

The Containment internal structural concrete components are exposed to the Containment air environment (see Table 3.0-2).

3.6.1.4.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of the intended function(s) for Containment internal structural concrete components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Loss of material is manifested in Containment internal structural concrete components as scaling, spalling, pitting, and erosion. Aging mechanisms that can lead to loss of material are freeze-thaw, abrasion and cavitation, aggressive chemical attack, corrosion of reinforcing and embedded steel, and elevated temperature.

As discussed in Section 3.6.1.1.2, freeze-thaw and abrasion and cavitation were evaluated for concrete components at Turkey Point and determined not to be aging mechanisms that can lead to loss of material for Containment internal structural concrete components.

There are no Containment internal structural concrete components exposed to the groundwater and, therefore, aggressive chemical attack and corrosion of reinforcing and embedded steel are not aging mechanisms that can lead to loss of material for Containment internal structural concrete components.

Elevated temperature was evaluated as an aging mechanism. The primary shield wall concrete is subject to extended local heatup. The combination of component insulation, ventilation systems, concrete wall design, and plant Technical Specifications maintains the temperatures in the primary shield walls below degradation threshold and localized temperature limits of ACI standards. No other concrete components are exposed to elevated temperature. Therefore, elevated temperature is not an aging mechanism that can lead to loss of material for Containment internal structural concrete components.

Based on the above, loss of material is not an aging effect requiring management for Containment internal structural concrete components.

CRACKING

Cracking is manifested in Containment internal structural concrete components as complete or incomplete separation of the concrete into two or more parts. Aging mechanisms that can lead to cracking are freeze-thaw, reactions with aggregates, shrinkage, settlement, fatigue, and elevated temperature.

As previously discussed in Section 3.6.1.1.2, freeze-thaw, reactions with aggregates, shrinkage, settlement, and fatigue were evaluated for concrete components at Turkey Point and are not aging mechanisms that can lead to cracking for Containment internal structural concrete components.

As discussed in Subsection 3.6.1.1.2, the concrete components do not exceed established threshold limits for degradation due to elevated temperature. Therefore, elevated temperature is not an aging mechanism that can lead to cracking for Containment internal structural concrete components.

Based on the above, cracking is not an aging effect requiring management for Containment internal structural concrete components.

CHANGE IN MATERIAL PROPERTIES

Change in material properties is manifested in concrete as increased permeability, increased porosity, reduction in pH, reduction in tensile strength, reduction in compressive strength, reduction in modulus of elasticity, and reduction in bond strength. Aging mechanisms that can lead to a change in material properties are leaching, creep, aggressive chemical attack, irradiation embrittlement, and elevated temperature.

As previously discussed in Section 3.6.1.1.2, leaching and creep were evaluated for concrete components at Turkey Point and are not aging mechanisms that can lead to change in material properties for Containment internal structural concrete components.

There are no internal components exposed to the groundwater and, therefore, aggressive chemical attack is not an aging mechanism that can lead to change in material properties for Containment internal structural concrete components.

Irradiation embrittlement was evaluated as an aging mechanism that could lead to change in material properties. Shielding from the water in the reactor core and the reactor vessel reduces the neutron flux, resulting in levels of accumulated exposure that are far below the degradation threshold. Neutron flux levels at the primary shield wall are well below the threshold levels for age-related radiation or radiation heating degradation. The maximum gamma dose evaluated through the period of extended operation is below the dose required for radiation degradation. Therefore, irradiation embrittlement is not an aging mechanism that can lead to change in material properties for Containment internal structural concrete components.

As discussed previously, the Containment internal structural concrete components do not exceed established threshold limits for degradation due to elevated temperature. Therefore, elevated temperature is not an aging mechanism that can lead to change in material properties for Containment internal structural concrete components.

Based on the above, change in material properties is not an aging effect requiring management for Containment internal structural concrete components.

3.6.1.4.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history that included reviews of the NRC generic communications and licensee event reports was performed to validate the set of aging mechanisms that cause the aging effects in Subsection 3.6.1.4.2. The industry correspondence that was found applicable to the Containment internal structural concrete components is provided in Subsection 3.6.1.1.3.

No aging effects requiring management were identified from the documents listed in Subsection 3.6.1.1.3 beyond those already identified in Subsection 3.6.1.4.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of Containment internal structural concrete component aging, in addition to interviews with responsible engineering personnel.

No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.1.4.2.

3.6.1.4.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no aging effects requiring management as discussed in Subsection 3.6.1.4.2. Table 3.6-2 contains the results of the aging management review for the Containments and indicates there are no aging effects requiring management for Containment internal structural concrete components.

Based on the aging management review discussed above, the intended functions for the Containment internal structural concrete components will be maintained consistent with the current licensing basis for the period of extended operation.

3.6.1.5 CONTAINMENT INTERNAL STRUCTURAL STEEL COMPONENTS

The Containment internal structural steel components are:

- equipment component supports
- heating, ventilation and air-conditioning (HVAC) ductwork supports
- piping supports
- pipe whip restraints (excluding Reactor Coolant System loop piping within the scope of Leak Before Break – Subsection 4.2.3)
- cable trays, conduits, and supports
- electrical and instrument panels and enclosures
- anchorages/embedments exposed surfaces
- instrument line supports
- instrument racks and frames
- structural steel beams and columns
- stairs, platforms, and grating
- sump screens
- Lubrite plates
- radiant energy shields

- polar crane
- Reactor Coolant System supports (including reactor vessel supports, steam generator supports, reactor coolant pump supports, pressurizer supports, and the surge line support)
- non-safety related piping between class break and anchor

Table 3.6-2 contains a list of Containment internal structural steel components addressed by this aging management review. Note: The refueling pool liner and structural steel components associated with spent fuel handling equipment located inside the Containment are addressed in Subsection 3.6.2.

3.6.1.5.1 MATERIALS AND ENVIRONMENT

The Containment internal structural steel component design complies with AISC Manual of Steel Construction for the structural steel. The codes and standards used for design and fabrication of the Containment internal structural steel components are provided in Turkey Point UFSAR Subsections 5.1.2 and 5.1.6.

The materials of construction for the Reactor Coolant System supports include structural steels, low alloy steels, and carbon steel pipe. The primary bolting material is carbon steel. The Reactor Coolant System supports are described in Turkey Point UFSAR Section 4.2.

The Containment internal structural steel components are exposed to the containment air environment. In addition, Containment internal structural steel components may be exposed to treated water and treated water – borated environments and potential borated water leaks (see Table 3.0-2).

Pipe segments beyond the safety-related/non-safety related boundaries are constructed of carbon and stainless steel and consist of piping and inline components. The external surfaces of these pipe segments are exposed to the containment air environment. Internal environments of the pipe segments are the same as the internal environments for the systems in which they are installed.

3.6.1.5.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of the intended function(s) for Containment internal structural steel components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Aging mechanisms that can lead to loss of material for Containment internal structural steel components are material compatibility, mechanical wear, corrosion, and aggressive chemical attack.

As previously discussed in Subsection 3.6.1.2.2, material compatibility and mechanical wear were evaluated for structural steel components at Turkey Point and determined not to be aging mechanisms that can lead to loss of material for Containment internal structural steel components.

Loss of material in steel may be caused by corrosion. This can be seen as material dissolution, corrosion product buildup, and pitting. It can be uniform or localized.

Aggressive chemical attack due to boric acid is an aging mechanism for Containment internal structural steel components. This form of corrosion is typically localized and is a result of leakage from the Reactor Coolant and other borated systems that can concentrate boric acid and lead to significant material loss of carbon steel components. Although this type of corrosion is event driven (boric acid leak), boric acid corrosion was evaluated as an aging mechanism at Turkey Point.

Based on the above, loss of material due to corrosion and aggressive chemical attack is an aging effect requiring management for Containment internal structural steel components.

CRACKING

Aging mechanisms that can lead to cracking of structural steel components are fatigue and stress corrosion cracking.

For steel components, fatigue is the cumulative effect of microstructural localized plastic deformation in the material section that results each time a stress cycle of sufficient magnitude occurs. Steel components in the containment subjected to high-cycle (>10^5 cycles) loading conditions were designed in accordance with AISC standards. Fatigue degradation will have no adverse effects on the continued intended function(s) performance during the license renewal term and no further evaluation for steel components in the Containment is required. Fatigue is not an aging mechanism that can lead to cracking for Containment internal structural steel components.

Stress corrosion cracking is a localized, non-ductile cracking failure from an unfavorable combination of sustained tensile stress, material condition, and environment. Stress corrosion cracking can only occur when all three conditions exist simultaneously. At Turkey Point, it was determined that the combination of conditions required for stress corrosion cracking do not exist simultaneously, therefore, stress corrosion cracking cannot occur in Containment internal structural steel components.

Based on the above, cracking is not an aging effect requiring management for Containment internal structural steel components.

CHANGE IN MATERIAL PROPERTIES

Aging mechanisms that can lead to change in material properties are elevated temperature, irradiation embrittlement, and creep and stress relaxation.

Elevated temperature was evaluated as an aging mechanism. For Containment internal structural steel components, a temperature of 700°F must be reached before significant reductions in the yield strength and modulus of elasticity occur. Since the operating temperatures of the Containment internal structural steel components are below the threshold temperature, the temperature at which structural integrity of the steel would begin to be affected will not be reached. Therefore, elevated temperature is not an aging mechanism that can lead to change in material properties for Containment internal structural steel components.

Irradiation embrittlement was evaluated as an aging mechanism that could lead to change in material properties. Shielding from the water in the reactor core and the reactor vessel reduces the neutron flux, resulting in levels of accumulated exposure that are far below the degradation threshold. Therefore, irradiation embrittlement is not an aging mechanism that can lead to change in material properties for Containment internal structural steel components.

Creep is a continuous physical deformation with time for a metal under a constant applied stress. Stress relaxation is a reduction in stress with time under a given constant strain. Creep and stress relaxation are strongly affected by temperature. Generally, creep and stress relaxation are insignificant when the service temperature to melting temperature ratio is less than 0.5. Since the temperature in the Reactor Coolant System supports is below 650°F, creep and stress relaxation do not cause effects requiring aging management for Containment internal structural steel components.

Based on the above, change in material properties is not an aging effect requiring management for Containment internal structural steel components.

3.6.1.5.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to Containment internal structural steel components is provided in Subsection 3.6.1.2.3.

No aging effects requiring management were identified from the documents listed in Subsection 3.6.1.2.3 beyond those already identified in Subsection 3.6.1.5.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of Containment internal structural steel component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.1.5.2.

3.6.1.5.4 REACTOR COOLANT SYSTEM SUPPORTS TECHNICAL REPORT APPLICABILITY

Westinghouse Generic Topical Report, WCAP-14422, "License Renewal Evaluation: Aging Management for Reactor Coolant System Supports" [Reference 3.6-2], has been submitted to the NRC for review and approval. The NRC issued a draft safety evaluation report for WCAP-14422 [Reference 3.6-3] on February 25, 2000. This aging management review is based on that Generic Technical Report, however, WCAP-14422 is not incorporated by reference in this Application.

Turkey Point reviewed the current design and operation of the Reactor Coolant System supports using the process described in Subsection 2.3.1.1.1 and confirmed that the operating environments used in the design of the Turkey Point Reactor Coolant System supports are consistent with the description contained in

WCAP-14422. The Reactor Coolant System supports contain materials beyond those listed in Table 2-4 of WCAP-14422. These additional materials were included in the Reactor Coolant System supports aging management review described in Subsection 3.6.1.5. The component intended functions for the Turkey Point Reactor Coolant System supports are consistent with the intended functions identified in WCAP-14422.

As a result of the NRC review of WCAP-14422, several open items and license renewal applicant action items were identified. These open items and applicant action items are described in the draft NRC safety evaluation of WCAP-14422. Turkey Point-specific responses to those open items and applicant action items relevant to the identification of Reactor Coolant System supports subject to aging management review are provided in Tables 2.4-1 and 2.4-2. Major component supports are described in UFSAR Subsection 5.1.9.

Based on the results of Turkey Point's review to identify Time-Limited Aging Analyses (see Section 4.0), there are no Time-Limited Aging Analyses associated with Reactor Coolant System supports. This is consistent with the discussion of Time-Limited Aging Analyses in WCAP-14422.

The aging management programs described in WCAP-14422 include six attributes and are established on an aging mechanism basis. The Turkey Point aging management programs referred to in this aging management review and described in Appendix B contain ten attributes, and are established on a program basis.

Additionally, WCAP-14422 identifies stress corrosion cracking of support bolting as an aging effect requiring management. Based on the discussion in Subsection 3.6.1.5.2 under "Cracking," Turkey Point has concluded that stress corrosion cracking of support bolting does not require aging management.

3.6.1.5.5 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.1.5.2. Table 3.6-2 contains the results of the aging management review for the Containments and summarizes the aging effects requiring management for Containment internal structural steel components.

The aging effects requiring management are adequately managed by the following programs:

- ASME Section XI, Subsection IWF Inservice Inspection Program
- Boric Acid Wastage Surveillance Program
- Systems and Structures Monitoring Program

Based on the evaluations provided in Appendix B for the programs listed above, aging effects are adequately managed so that that the intended functions of the Containment internal structural steel components listed in Table 3.6-2 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.2 OTHER STRUCTURES

This aging management review identifies and evaluates aging effects on Turkey Point passive, long-lived structures and structural components (other than the Containments and selected structural components). Structures and structural components within the scope of license renewal and subject to aging management reviews are discussed in Section 2.4 and include:

- Auxiliary Building
- Cold Chemistry Lab
- Control Building
- Cooling Water Canals
- Diesel Driven Fire Pump Enclosure
- Discharge Structure
- Electrical Penetration Rooms
- Emergency Diesel Generator Buildings
- Fire Protection Monitoring Station
- Fire Rated Assemblies
- Intake Structure
- Main Steam and Feedwater Platforms
- Plant Vent Stack
- Spent Fuel Storage and Handling
- Turbine Building
- Turbine Gantry Cranes
- Turkey Point Units 1 and 2 Chimneys
- Yard Structures

Tables 3.6-3 through 3.6-20 contain the specific structural component and commodity groups, materials, intended functions, environments, aging effects, and aging management programs for each of the structures listed above. Structural components are grouped by material and environment for each structure. The structural component groups are:

- Steel in air
- Steel in fluid
- Concrete
- Miscellaneous

3.6.2.1 STEEL IN AIR STRUCTURAL COMPONENTS

Steel in air structural components include:

- framing, bracing, and connections
- decking, grating, and checkered plate
- stairs and ladders
- exposed anchors and embedments
- piping, duct, and component supports
- non-safety related piping between class break and anchor
- crane rails and girders
- cable trays, conduits, and electrical enclosures
- cable tray, conduit, and electrical enclosure supports
- instrumentation supports
- instrument racks and frames

3.6.2.1.1 MATERIALS AND ENVIRONMENT

Steel in air structural components were designed and constructed in accordance with AISC standards. The codes and standards used for the design and fabrication are identified in UFSAR Chapter 5. Steel in air structural components are constructed of painted or galvanized carbon steel and stainless steel. Turkey Point steel in air structural components are exposed to environments of containment air, outdoor, indoor – not air conditioned, indoor – air conditioned, and potential borated water leaks (see Table 3.0-2). The specific materials and environments for steel in air structural components for each structure are contained in Tables 3.6-3 through 3.6-20.

Pipe segments beyond the safety-related/non-safety related boundaries are constructed of carbon and stainless steel and consist of piping and inline components. The external surfaces of these pipe segments are exposed to the Indoor – not air conditioned and outdoor environments and potential borated water leaks. Internal environments of the pipe segments are the same as the internal environments for the systems in which they are installed.

3.6.2.1.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of the intended function(s) of steel in air structural components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Aging mechanisms that can lead to loss of material are mechanical wear, corrosion, and aggressive chemical attack. This may be seen as material dissolution, corrosion product buildup, and pitting. Loss of material may be uniform or localized.

Mechanical wear is associated with close fitting mechanical components and is not applicable to structural steel. Accordingly, mechanical wear is not an aging mechanism that can lead to loss of material in steel in air structural components.

Loss of material in steel may be caused by corrosion. Carbon steel in an air environment is susceptible to corrosion except in the following situations: the steel is located in an air conditioned environment, or the steel is galvanized and not wetted. Stainless steel structural components are not subject to corrosion for the environments at Turkey Point. Accordingly, with the exceptions above, corrosion is an aging mechanism that can lead to loss of material in steel in air structural components.

Aggressive chemical attack due to boric acid is an aging mechanism for steel in air structural components. This form of corrosion is typically localized and is a result of leakage from borated water systems that can concentrate boric acid and lead to significant material loss of carbon steel components. Although this type of corrosion is event driven (boric acid leaks), boric acid corrosion was evaluated as an aging mechanism at Turkey Point.

Based on the above, loss of material due to corrosion and aggressive chemical attack is an aging effect requiring management for steel in air structural components.

CRACKING

Aging mechanisms that can lead to cracking of steel in air structural components are stress corrosion and fatigue.

Stress corrosion cracking is an age-related degradation mechanism that affects stainless steels but becomes significant only if tensile stresses and a corrosive environment exist. The stresses may be either applied (external) or residual (internal). The stress corrosion cracks themselves may be either transgranular or intergranular, depending upon the metal and the corrosive agent. As is normal in all cracking, the cracks are perpendicular to the tensile stress. Usually there is little or no obvious visual evidence of corrosion. Stress corrosion cracking is not an aging mechanism that can lead to cracking for steel in air structural components.

Fatigue is a progressive degradation problem for materials subjected to cyclic application of loads that are less than the maximum allowable static loads. For steel components, fatigue is the cumulative effect of microstructural localized plastic deformation in the material section that results each time a stress cycle of sufficient magnitude occurs. Fatigue is not an aging mechanism that can lead to cracking in steel in air structural components.

Based on the above, cracking is not an aging effect requiring management for steel in air structural components.

CHANGE IN MATERIAL PROPERTIES

Aging mechanisms that can cause change in material properties are thermal and irradiation embrittlement. Steel in air structural components outside the Containment are not exposed to the elevated temperatures or fluences that would cause reduction in fracture toughness. The only steel in air structural components inside Containment and within the scope of this subsection are those associated with fuel handling equipment. These structural components are also not subject to the elevated temperatures and fluences necessary for reduction in fracture toughness. Accordingly, change in material properties is not an aging effect requiring management for steel in air structural components.

3.6.2.1.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to steel in air structural components includes the following:

- NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants"
- NRC Information Notice 89-07, "Failures of Small-Diameter Tubing in Control Air, Fuel Oil, and Lube Oil Systems Render Emergency Diesels Inoperable"
- NRC Information Notice 89-80, "Potential For Water Hammer, Thermal Stratification, and Steam Binding in High Pressure Coolant Injection Piping"
- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"
- NUREG-1557, "Summary of Technical Information and Agreements from Nuclear Management and Resources Council Industry Reports Addressing License Renewal"

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.2.1.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of steel in air structural component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.2.1.2.

3.6.2.1.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.2.1.2. Tables 3.6-3 through 3.6-20 contain the results of the aging management review for the other structures and summarize the aging effects requiring management for steel in air structural components.

The aging effects requiring management are adequately managed by the following programs:

- ASME Section XI, Subsection IWF Inservice Inspection Program
- Boric Acid Wastage Surveillance Program
- Systems and Structures Monitoring Program

Based on the evaluations provided in Appendix B for the programs listed above, aging effects are adequately managed so that the intended functions of the steel in air structural components listed in Tables 3.6-3 through 3.6-20 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.2.2 STEEL IN FLUID STRUCTURAL COMPONENTS

This subsection includes steel structural components that are exposed to fluids and those steel components that are exposed to both fluids and air. Steel structural components that are exposed to only an air environment were discussed in Subsection 3.6.2.1 above. Steel in fluid structural components include:

- refueling pool cavity liner plates
- spent fuel pool liner plates
- spent fuel handling equipment and tools
- spent fuel pool keyway gates
- fuel transfer tubes, penetration sleeves, and gate valves
- reactor cavity seal rings
- spent fuel storage racks and Boraflex
- spent fuel pool anchorages and embedments
- intake structure traveling screens

3.6.2.2.1 MATERIALS AND ENVIRONMENT

Steel in fluid structural components were designed and constructed in accordance with AISC standards. The codes and standards used for the design and fabrication of the steel in fluid structural components are identified in Turkey Point UFSAR Chapter 5.

Steel in fluid structural components are constructed of painted carbon steel or stainless steel. In addition, the spent fuel storage racks contain Boraflex panels.

Turkey Point steel in fluid structural components are exposed to fluid environments of raw water – cooling canals and treated water – borated, and air environments of Containment air, indoor – not air conditioned, and outdoor (see Tables 3.0-1 and 3.0-2). The specific materials and environments for steel in fluid structural components for each structure are contained in Tables 3.6-3 through 3.6-20.

3.6.2.2.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of intended function(s) for steel in fluid structural components are loss of material, cracking, and change in material properties. The aging mechanisms that could lead to these aging effects in steel in fluid structural components were evaluated using the methodology provided in Appendix C. The results are provided below.

LOSS OF MATERIAL

Aging mechanisms that can lead to loss of material are leaching, aggressive chemical attack, mechanical wear, and corrosion.

Based on the evaluation using the methodology described in Appendix C, leaching, aggressive chemical attack, and mechanical wear are not aging mechanisms that can lead to loss of material in steel in fluid structural components.

Loss of material for steel in fluid structural components may be caused by corrosion. This may be seen as material dissolution, corrosion product buildup, and pitting. Loss of material may be uniform or localized.

Based on the above, loss of material due to corrosion is an aging effect requiring management for steel in fluid structural components.

CRACKING

Aging mechanisms that can lead to cracking of steel in fluid structural components are fatigue, hydrogen damage, and stress corrosion cracking.

Based on the evaluation using the methodology described in Appendix C, fatigue, hydrogen damage, and stress corrosion cracking were evaluated for steel in fluid structural components at Turkey Point and determined not to lead to cracking requiring management. Accordingly, cracking is not an aging effect requiring management for steel in fluid structural components.

CHANGE IN MATERIAL PROPERTIES

Aging mechanisms that can cause change in material properties are creep and stress relaxation, and thermal and irradiation embrittlement.

Based on the evaluation using the methodology described in Appendix C, creep and stress relaxation were evaluated for steel in fluid structural components at Turkey Point and determined not to lead to change in material properties.

Steel in fluid structural components outside Containment are not exposed to the elevated temperatures or fluences that would cause reduction in fracture toughness. The only steel in fluid structural components inside Containment and within the scope of this subsection are the reactor refueling cavity liner and those associated with fuel handling equipment. These structural components are also not subject to the elevated temperatures and fluences necessary for reduction in fracture toughness. Accordingly, change in material properties is not an aging effect requiring management for steel in fluid structural components.

Boraflex is a neutron absorber inserted between the fuel storage cells in high-density fuel storage racks. Irradiation results in embrittlement of the Boraflex inserts.

Based on the above, change in material properties due to irradiation of fuel storage rack Boraflex inserts is an aging effect requiring management.

3.6.2.2.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to steel in fluid structural components includes the following:

- NRC Bulletin 94-01, "Potential Fuel Pool Draindown Caused by Inadequate Maintenance Practices at Dresden Unit 1"

- NRC Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants"
- NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment"
- NRC Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks"
- NRC Information Notice 87-43, "Gaps in Neutron-Absorbing Material in High Density Spent Fuel Storage Racks"
- NRC Information Notice 89-07, "Failures of Small-Diameter Tubing in Control Air, Fuel Oil, and Lube Oil Systems Render Emergency Diesels Inoperable"
- NRC Information Notice 89-80, "Potential For Water Hammer, Thermal Stratification, and Steam Binding in High Pressure Coolant Injection Piping"
- NRC Information Notice 93-70, "Degradation of Boraflex Neutron Absorber Coupons"
- NRC Information Notice 95-38, "Degradation of Boraflex Neutron Absorber in Spent Fuel Storage Racks"
- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.2.2.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of steel in fluid structural component aging, in addition to interviews with responsible engineering personnel. No additional aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.2.2.2.

3.6.2.2.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.2.2.2. Tables 3.6-3 through 3.6-20 contain the results of the aging management review for the other structures and summarize the aging effects requiring management for steel in fluid structural components.

The aging effects requiring management are adequately managed by the following programs:

- Boraflex Surveillance Program
- Chemistry Control Program
- Periodic Surveillance and Preventive Maintenance Program
- Systems and Structures Monitoring Program

Based on the evaluations provided in Appendix B for the programs listed above, aging effects are adequately managed so that the intended functions of the steel in fluid structural components listed in Tables 3.6-3 through 3.6-20 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.2.3 CONCRETE STRUCTURAL COMPONENTS

Concrete structural components include:

- foundations
- columns
- walls
- floors
- roofs
- equipment pads
- electric duct banks
- manholes
- trenches
- masonry block walls
- embedded steel
- embedded anchors
- concrete piping

3.6.2.3.1 MATERIALS AND ENVIRONMENT

Concrete structural components were designed and constructed in accordance with ACI and ASTM standards. The codes and standards used for the design and fabrication of the concrete structural components are identified in UFSAR Chapter 5.

Turkey Point concrete structural components are exposed to environments of outdoor, indoor – not air conditioned, indoor – air conditioned, buried, raw water – cooling canals, and embedded/encased (see Table 3.0-2). The specific materials and environments for concrete structural components for each structure are contained in Tables 3.6-3 through 3.6-20.

3.6.2.3.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of intended function(s) for concrete structural components are loss of material, cracking, and change in material properties. Each is discussed below.

LOSS OF MATERIAL

Loss of material is manifested in concrete structural components as scaling, spalling, pitting and erosion. Aging mechanisms that can lead to loss of material are freeze-thaw, abrasion and cavitation, elevated temperature, aggressive chemical attack, and corrosion of reinforcing and embedded/encased steel.

Freeze-thaw is considered an aging mechanism for concrete structural components that are exposed to severe weather conditions of numerous freeze-thaw cycles with significant amounts of winter rainfall. Turkey Point is located in a subtropical climate with long, warm summers accompanied by abundant rainfall and mild, dry winters with negligible freeze-thaw cycles. Therefore, freeze-thaw is not an aging mechanism that can lead to loss of material for concrete structural components.

Abrasion and cavitation is an aging mechanism that occurs only in concrete structures that are continually exposed to flowing water. The Intake Structure concrete components located below the intake canal water level and the intake cooling water piping are the only concrete components exposed to flowing water. The velocity in the intake canal and the velocity in the intake cooling water piping are significantly less than the threshold limits at which abrasion and cavitation degradation occurs. Therefore, abrasion and cavitation is not an aging mechanism that can lead to loss of material for concrete structural components.

Concrete structural components outside Containment are not exposed to elevated temperatures that exceed ACI threshold limits and, therefore, elevated temperature is not an aging mechanism that can lead to loss of material for concrete structural components.

Aggressive chemical attack, leading to corrosion of reinforcing steel and embedded steel, was identified as an age-related degradation mechanism for concrete structural components. At Turkey Point, this is applicable to concrete structural components exposed to the groundwater, saltwater flow, or saltwater splash (Intake Cooling Water System discharge). The structures with concrete structural components located below groundwater elevation are the Intake Structure, Discharge Structure, and the floors and lower wall portions of the residual heat removal pump and heat exchanger rooms in the Auxiliary Building. The concrete structural components at the Intake and Discharge Structures are also exposed to high chlorides due to the flow of saltwater. The Discharge Structure headwalls are exposed to discharge canal and Intake Cooling Water System discharge splash.

Based on the above, loss of material due to aggressive chemical attack and corrosion of reinforcing and embedded steel is an aging effect that requires aging management for concrete structural components below groundwater elevation, exposed to saltwater flow, or exposed to saltwater splash.

CRACKING

Cracking is manifested in concrete structural components as complete or incomplete separation of the concrete into two or more parts. Aging mechanisms that can lead to cracking are freeze-thaw, reactions with aggregates, fatigue, shrinkage, settlement, and elevated temperature.

As discussed previously, freeze-thaw is not an aging mechanism that can lead to cracking for concrete structural components.

Turkey Point concrete components were constructed using non-reactive aggregates whose acceptability was based on established industry standards and ASTM tests. Therefore, reaction with aggregates is not an aging mechanism that can lead to cracking for concrete structural components.

Fatigue is a progressive degradation problem for materials subjected to cyclic application of loads that are less than the maximum allowable static loads. Turkey Point concrete components are designed in accordance with ACI standards and have good low-cycle fatigue properties. Although some concrete components are subject to high cycles of low-level repeated load, these components were designed in accordance with ACI standards, which limit the maximum design stress to less than 50% of the static stress of the concrete. The concrete fatigue strength is about 55% of its static strength at extremely high cycles ($>10^7$ cycles) of loading. Therefore, fatigue is not an aging mechanism that can lead to cracking for concrete structural components.

When concrete is exposed to air, large portions of the free water evaporate, causing shrinkage. At Turkey Point, the initial concrete water content was kept low, low slump concrete was used, and adequate steel reinforcement was provided, which all minimize shrinkage. Based on industry information, 100% of concrete shrinkage occurs within 20 years. Turkey Point concrete structures and concrete components were constructed more than 20 years ago; therefore, concrete shrinkage is not an aging mechanism that can lead to cracking for concrete structural components.

Settlement is based directly on the physical properties of a structure's foundation material. The most pronounced settlement is evidenced in the first several months after construction. Turkey Point concrete structures are founded on fossiliferous limestone bedrock (Miami Oolite) with crushed limestone fill. This foundation material is suitable for foundation systems with no significant structural settlement expected. Therefore, settlement is not an aging mechanism that can lead to cracking for concrete structural components.

Shrinkage and settlement of supporting structures can cause cracking of unreinforced masonry block walls. Cracking could reduce the structural strength of the wall. Any cracks that affected the structural integrity and could consequently impact the intended function(s) of the masonry block walls were identified in response to NRC Bulletin 80-11 and associated inspections.

Concrete structural components outside Containment are not exposed to elevated temperatures that exceed ACI threshold limits and, therefore, elevated temperature is not an aging mechanism that can lead to cracking for concrete structural components.

Based on the above, cracking due to shrinkage and settlement of unreinforced masonry block walls is an aging effect requiring management for concrete structural components.

CHANGE IN MATERIAL PROPERTIES

Change in material properties is manifested in concrete as increased permeability, increased porosity; reduction in pH; reduction in tensile, compressive, or bond strength; and reduction in modulus of elasticity. Aging mechanisms that can lead to a change in material properties are leaching, creep, elevated temperature, irradiation embrittlement, and aggressive chemical attack.

Leaching of calcium hydroxide is observed on concrete that is alternately wetted and dried. White deposits that are left on the surface of the concrete are a solution of water, free lime from the concrete, and carbon dioxide that is readily seen on the surface of the concrete. Turkey Point concrete structures and concrete components are constructed of a dense, well-cured concrete with an amount of cement suitable for strength development, and achievement of a water-to-cement ratio that is characteristic of concrete having low permeability. This is consistent with the guidance provided by the ACI, and when implemented, degradation caused by leaching of calcium hydroxide is not significant. Therefore, leaching is not an aging mechanism that can lead to change in material properties for concrete structural components.

Creep is significant when new concrete is subjected to load and decreases exponentially with time; and any degradation is noticeable in the first few years. All reinforced concrete components were designed based on the ACI working stress design method. Creep in all concrete components is minimal because of low compressive stresses in concrete and the use of high strength concrete. In addition, creep proceeds at a decreasing rate with age, 96% of creep has occurred within 30 years; and therefore, concrete creep is not an aging mechanism that can lead to change in material properties for concrete structural components.

Concrete structural components outside Containment are not exposed to elevated temperature or fluences that would cause embrittlement.

Concrete structural components subject to loss of material due to aggressive chemical attack would also be subject to change in material properties due to the same aging mechanism.

Based on the above, change in material properties due to aggressive chemical attack is an aging effect requiring management for concrete structural components below groundwater elevation, exposed to saltwater flow, or exposed to saltwater splash.

3.6.2.3.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to concrete structural components includes the following:

- NRC Bulletin 80-11, "Masonry Wall Design"
- NRC Information Notice 97-11, "Cement Erosion from Containment Subfoundations at Nuclear Power Plants"
- NRC Information Notice 98-26, "Settlement Monitoring and Inspection of Plant Structures Affected by Degradation of Porous Concrete Subfoundations"
- NUREG-1522, "Assessment of Inservice Conditions of Safety-Related Nuclear Plant Structures"
- NUREG/CR-4652, "Concrete Component Aging and its Significance Relative to Life Extension of Nuclear Power Plants"
- NUREG/CP-0100, Prasad, N., et al., "Concrete Degradation Monitoring and Evaluation", Proceedings of the International Nuclear Power Plant Aging Symposium, August 30 – September 1, 1998

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.2.3.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of concrete structural component aging, in addition to interviews with responsible engineering personnel. No additional aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.2.3.2.

3.6.2.3.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.2.3.2. Tables 3.6-3 through 3.6-20 contain the results of the aging management review for the other structures and summarize the aging effects requiring management for concrete structural components.

The aging effects requiring management are adequately managed by the following program:

- Systems and Structures Monitoring Program

Based on the evaluation provided in Appendix B for the program above, aging effects are adequately managed so that the intended functions of the concrete structural components listed in Tables 3.6-3 through 3.6-20 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.2.4 MISCELLANEOUS STRUCTURAL COMPONENTS

Miscellaneous structural components include:

- fire rated assemblies (fire penetration seals, fire retardant coatings, and fire doors)
- Cooling Water Canals
- weatherproofing (structures and sealants)
- flood protection seals and stop logs
- Control Room ceiling and raised floor

3.6.2.4.1 MATERIALS AND ENVIRONMENT

The miscellaneous structural components consist of a variety of materials, depending on their location and function. Materials used include painted and galvanized carbon steel, aluminum, earth/rock, wood, gypsum board, acoustical panels, weatherproofing materials (silicone caulking, sealants and foams, neoprene gaskets, asphalt, felt, and membrane roofing), and fire protection materials (silicone foams, elastomers and gels, mineral wool, alumina-silica, ceramic fiber blankets, ceramic fiber boards, calcium silicate board, flexible boots, Thermo-Lag, Flamemastic, and cementitious coatings).

The miscellaneous structural components are exposed to different environments, depending on their location and function. Environments include outdoor, indoor – not air conditioned, and indoor – air conditioned (see Table 3.0-2). The specific materials and environments for miscellaneous structural components for each structure are contained in Tables 3.6-3 through 3.6-20.

3.6.2.4.2 AGING EFFECTS REQUIRING MANAGEMENT

The aging effects that could cause loss of intended function(s) for miscellaneous structural components are loss of material and loss of seal. Both are discussed below.

LOSS OF MATERIAL

Aging mechanisms that can lead to loss of material are wear, weathering, corrosion, organic decomposition.

Wear, weathering, organic decomposition, and corrosion were evaluated for loss of material of the fire rated assemblies, cooling water canals, weatherproofing (structures and sealants), Control Room ceiling and raised floor, and the Fire Protection Monitoring Station miscellaneous structural components. Except for some fire retardant coatings and fire doors, wear, weathering, organic decomposition, and corrosion do not lead to loss of material for miscellaneous structural components.

Fire rated assemblies, except for some fire retardant coatings and fire doors, when cured, become monolithic solids taking the form of the system to which each is injected or applied. In addition, SECY 96-146 concludes that penetration seals are not subjected to aging effects.

Raceway material fire retardant coatings, installed as part of the 10 CFR 50 Appendix R upgrades, were provided by Thermo-Lag. Thermo-Lag locations exposed to an outdoor environment have experienced topcoat damage and, therefore, loss of material due to weathering is an aging effect requiring management for Thermo-Lag insulation materials.

Fire doors are passive features to seal passageways through fire barriers and are constructed of carbon steel. Carbon steel in outdoor and indoor – not air conditioned environments is susceptible to corrosion. Therefore, loss of material due to corrosion is an aging effect requiring management for certain fire doors.

The Cooling Water Canals provide a source of cooling water for plant shutdown. The heat load for shutdown is a small percentage of the normal operating heat load. Weathering and organic decomposition are not aging mechanisms that could lead to loss of material of the Cooling Water Canals that could cause loss of intended function(s).

The Control Room ceiling and raised floor and the Fire Protection Monitoring Station are indoor – air conditioned environments that are occupied 24 hours per day. Should indication of an aging effect arise in these areas it would be identified and corrected.

The miscellaneous structural components that provide flood protection include wooden and aluminum stop logs, and the pipe trench penetration seals. Aluminum is highly resistant to corrosion. Aluminum stop logs and pipe trench penetrations have been evaluated for loss of material and determined not to require aging management. Wooden stop logs are subject to loss of material due to organic decomposition and, therefore, loss of material due to organic decomposition is an aging effect requiring management for wooden stop logs.

Based on the above, loss of material due to weathering, corrosion, and organic decomposition is an aging effect requiring management for miscellaneous structural components.

LOSS OF SEAL

The aging mechanism that can lead to loss of seal is weathering.

The covers of manholes containing redundant safe shutdown cables are sealed to prevent the spread of flammable or combustible liquids into manholes. Sealant material is chemically resistant to combustible liquid and does not burn readily. Sealant material is subject to loss of seal when exposed to weathering and, therefore, loss of seal due to weathering is an aging effect requiring management for manholes and associated sealants.

Weatherproofing includes both roofing systems and structural sealants. These components protect internal components from the effects of exposure to weather, primarily rainwater. Inspections are performed to ensure weatherproofing is functioning properly. Weatherproofing is exposed to environmental degradation that may potentially damage the sealant material. Loss of seal due to weathering is an aging effect requiring management for weatherproofing components.

The miscellaneous structural components that provide flood protection include wooden and aluminum stop logs, and the pipe trench penetration seals. Wooden and aluminum stop logs have been evaluated for loss of seal and determined not to require aging management. The penetration seals in the pipe trench are subject to loss of seal from exposure to weather and exhibit signs of decreased elasticity (drying out) and an increase in hardness and, thus, loss of seal.

Based on the above, loss of seal due to weathering is an aging effect requiring management for miscellaneous structural components.

3.6.2.4.3 OPERATING EXPERIENCE

INDUSTRY EXPERIENCE

A review of industry operating history and a review of NRC generic communications were performed to validate the set of aging effects that require management. The industry correspondence that was reviewed for operating experience related to miscellaneous structural components includes the following:

- NRC Bulletin 92-01, "Failure Of Thermo-Lag 330 Fire Barrier System To Maintain Cabling In Wide Cable Trays And Small Conduits Free From Fire Damage"
- NRC Bulletin 92-01, Supplement 1, "Failure of Thermo-Lag 330 Fire Barrier System to Perform Its Specified Fire Endurance Function"
- NRC Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers"
- NRC Information Notice 88-04, "Inadequate Qualification and Documentation of Fire Barrier Penetration Seals"
- NRC Information Notice 88-56, "Potential Problems with Silicone Foam Fire Barrier Penetration Seals"
- NRC Information Notice 91-47, "Failure of Thermo-Lag Fire Barrier Material to Pass Fire Endurance Test"
- NRC Information Notice 91-79, "Deficiencies in the Procedures for Installing Thermo-Lag Fire Barrier Materials"
- NRC Information Notice 91-79, Supplement 1, "Deficiencies Found in Thermo-Lag Fire Barrier Installation"

- NRC Information Notice 92-46, "Thermo-Lag Fire Barrier Material Special Review Team Final Report Findings, Current Fire Endurance Tests, And Ampacity"
- NRC Information Notice 92-55, "Current Fire Endurance Test Results For Thermo-Lag Fire Barrier Material"
- NRC Information Notice 92-82, "Results of Thermo-Lag 330-1 Combustibility Testing"
- NRC Information Notice 94-22, "Fire Endurance and Ampacity Derating Test Results for 3-hour Fire-Rated Thermo-Lag 330-1 Fire Barriers"
- NRC Information Notice 94-28, "Potential Problems With Fire-Barrier Penetration Seals"
- NRC Information Notice 94-34, "Thermo-Lag 330-660 Flexi-Blanket Ampacity Derating Concerns
- NRC Information Notice 95-32, "Thermo-Lag 330-1 Flame Spread Test Results"
- NRC Information Notice 95-49 and Supplement 1, "Seismic Adequacy of Thermo-Lag Panels"
- NRC Information Notice 97-70, "Potential Problems with Fire Barrier Penetration Seals"
- SECY-96-146, "Technical Assessment of Fire Barrier Penetration Seals in Nuclear Power Plants"

No aging effects requiring management were identified from the above documents beyond those already identified in Subsection 3.6.2.4.2.

PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was also reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of miscellaneous structural component aging, in addition to interviews with responsible engineering personnel. No aging effects requiring management were identified from this review beyond those identified in Subsection 3.6.2.4.2.

3.6.2.4.4 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.6.2.4.2. Tables 3.6-3 through 3.6-20 contain the results of the aging management review for the other structures and summarize the aging effects requiring management for miscellaneous structural components.

The aging effects requiring management are adequately managed by the following programs:

- Fire Protection Program
- Periodic Surveillance and Preventive Maintenance Program
- Systems and Structures Monitoring Program

Based on the evaluations provided in Appendix B for the programs listed above, aging effects are adequately managed so that the intended functions for the miscellaneous structural components listed in Tables 3.6-3 through 3.6-20 are maintained consistent with the current licensing basis for the period of extended operation.

3.6.3 REFERENCES

3.6-1 Final Environmental Statement Related to Operation of Turkey Point Plant, Florida Power and Light Company, Dockets No. 50-250 and 50-251, July 1972, United States Atomic Energy Commission Directorate of Engineering.

3.6-2 WCAP-14422, "License Renewal Evaluation: Aging Management for Reactor Coolant System Supports," Revision 2, March 1997.

3.6-3 C. I. Grimes (NRC) letter to R. A. Newton (WOG), "Draft Safety Evaluation Concerning the Westinghouse Owners Group License Renewal Evaluation: Aging Management for Reactor Coolant System Supports, WCAP-14422, Revision 2," February 25, 2000.

TABLE 3.6-1
STRUCTURAL COMPONENT INTENDED FUNCTIONS

1. Provide pressure boundary and/or fission product barrier.
2. Provide structural support to safety-related components.
3. Provide shelter/protection to safety-related components (including radiation shielding).
4. Provide rated fire barrier to retard spreading of a fire.
5. Provide a source of cooling water for plant shutdown.
6. Provide missile barrier.
7. Provide structural support to non-safety related components whose failure could prevent satisfactory accomplishment of any of the required safety-related functions.
8. Provide flood protection barrier.
9. Provide filtration of process fluid to protect downstream equipment.
10. Provide structural support and/or shelter to components required for fire protection, anticipated transients without scram (ATWS), and/or station blackout (SBO) events.

    NOTE: Although not credited in the analyses for these events, these components have been conservatively included in the scope of license renewal.
11. Provide pipe whip restraint and/or jet impingement protection.

TABLE 3.6-2
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete Walls above groundwater elevation (dome and cylinder walls)	2, 3, 4, 6, 7, 8, 10	Concrete	Buried Outdoor Indoor – not air conditioned	None	None required
Reinforced concrete Walls below groundwater elevation (cylinder walls and foundation mat)	2, 3, 7, 10	Concrete	Buried	Loss of material Change in material properties	Systems and Structures Monitoring Program
Anchorages/ embedments above groundwater elevation	1, 2, 7, 10	Carbon steel	Embedded/Encased	None	None required
Anchorages/ embedments below groundwater elevation	1, 2, 7, 10	Carbon steel	Embedded/Encased	Loss of material	Systems and Structures Monitoring Program
Internal reinforced concrete components: Beams Floor slabs Shield walls Secondary compartment walls Refueling cavity walls Equipment pads Missile shields Curbs Containment sumps Miscellaneous	2, 3, 6, 7, 8, 10	Concrete	Containment air	None	None required

TABLE 3.6-2 (continued) CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Carbon steel liner plates	1, 2, 7, 10	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Liner plate anchorages/ attachments exposed surfaces	1, 2, 7, 10	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Liner plate anchorages/ attachments	1, 2, 7, 10	Carbon steel	Embedded/Encased	None	None required
Mechanical piping penetrations	1, 2, 4	Carbon steel	Containment air Outdoor Indoor – not air conditioned	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Mechanical ventilation penetrations	1, 2, 4	Carbon steel	Containment air Outdoor	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Electrical penetrations	1, 2, 4	Carbon steel	Containment air Indoor – not air conditioned	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Containment personnel hatches Emergency escape hatches Equipment hatches	1, 4	Carbon steel	Containment air Outdoor	Loss of material	ASME Section XI, Subsection IWE Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Seals and gaskets (hatches)	1	Elastomers	Containment air Outdoor	Change in material properties	ASME Section XI, Subsection IWE Inservice Inspection Program
Moisture barriers	3	Elastomers	Containment air	Change in material properties	ASME Section XI, Subsection IWE Inservice Inspection Program

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fuel transfer tube blind flanges [1]	1, 4	Stainless steel	Containment air	None	None required
Cable trays Conduits	2, 7, 10	Carbon steel – galvanized	Containment air	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Conduit and cable tray supports	2, 7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Electrical, instrument panels and enclosures	2, 3, 7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Carbon steel – galvanized	Containment air	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Stainless steel	Containment air	None	None required
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

NOTE: 1. The fuel transfer tube, penetration sleeves, and gate valves are addressed in Table 3.6-16.

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Instrument line supports	2, 7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Structural steel: Beams Columns Elevators Stairs Platforms Grating	2, 7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Sump screens	9	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Safety-related piping and component supports	2, 10	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Non-safety related piping and component supports	7, 10	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Pipe whip restraints	11	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Non-safety related pipe segments between class break and seismic anchor	2, 7, 10	Stainless steel	Containment air	None	None required
		Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Radiant energy shields	4	Stainless steel	Containment air	None	None required
Miscellaneous structural components	2, 7, 10	Carbon steel - galvanized	Containment air	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Tendon wires	2	Carbon steel	In grease (sheathing filler material)	Loss of material	ASME Section XI, Subsection IWL Inservice Inspection Program

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Tendon anchorage components	2	Carbon steel	In grease (sheathing filler material)	Loss of material	ASME Section XI, Subsection IWL Inservice Inspection Program
Polar cranes: [1] Runway rail brackets Runway rails Main girders Cabs Footwalks & railings End connectors (fasteners) Electrical enclosures Trolley rails Trolley structures Control conductor supports	2, 7	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
Reactor vessel supports	2	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Stainless steel	Containment air	None	None required

NOTE: 1. Not exposed to potential borated water leakage.

TABLE 3.6-2 (continued)
CONTAINMENTS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Steam generator supports	2	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Lubrite	Containment air	None	None required
Pressurizer supports	2	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Reactor coolant supports	2	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Surge line supports	2	Carbon steel	Containment air	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-3
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Structural steel: Beams Columns Connections	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Miscellaneous steel: Stairs Platforms Grating	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
			Indoor – air conditioned	None	None required
Safety-related supports (pipe supports and component supports)	2, 10	Carbon steel	Indoor - not air conditioned	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
			Indoor – air conditioned	None	None required
Non-safety related supports	7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
			Indoor – air conditioned	None	None required

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Non-safety related pipe segments between class break and seismic anchor	2, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Stainless steel	Indoor - not air conditioned	None	None required
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Cable tray and conduit supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor –air conditioned	None	None required
		Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Electrical enclosures	2, 3, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized Stainless steel	Indoor - not air conditioned Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Electrical component supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Instrument racks and frames	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
HVAC duct supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Fan/filter intake hoods	3	Stainless steel	Outdoor	None	None required

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Pipe whip restraints	11	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Reinforced concrete: Foundations (above groundwater elevation)	2, 7,10	Concrete	Buried	None	None required
Reinforced concrete: Foundations and walls (residual heat removal pump and heat exchanger rooms below groundwater elevation)	2, 7, 10	Concrete	Buried	Loss of material Change in material properties	Systems and Structures Monitoring Program
Reinforced concrete: Beams Columns Walls Floors/slabs (above groundwater elevation)	2, 3, 4, 6, 7, 8, 10	Concrete	Indoor - not air conditioned Indoor – air conditioned Outdoor	None	None required
Reinforced block walls	2, 3, 4, 10	Concrete	Indoor - not air conditioned	None	None required

TABLE 3.6-3 (continued)
AUXILIARY BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Unreinforced block walls	2, 3, 4, 10	Concrete	Indoor - not air conditioned	Cracking	Systems and Structures Monitoring Program
Anchorages/ embedments (below groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	Loss of material	Systems and Structures Monitoring Program
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	None	None required
Weatherproofing	3	Caulking/ sealant Waterproofing membrane with concrete topping Asphalt roll roofing Flashing Roofing felt	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program
Pipe trench penetrations	8	Promatec flexible seal	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program
Stop logs	8	Wood	Outdoor	Loss of material	Periodic Surveillance and Preventive Maintenance Program
		Aluminum	Outdoor	None	None required

TABLE 3.6-4
COLD CHEMISTRY LAB

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete: Foundations (above groundwater elevation)	7	Concrete	Buried	None	None required
Reinforced concrete: Walls and roof	7	Concrete	Indoor - air conditioned Outdoor	None	None required

TABLE 3.6-5
CONTROL BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Structural steel: Beams Columns Connections	2, 7, 10	Carbon steel	Indoor – air conditioned	None	None required
Miscellaneous steel	2, 3, 6, 7, 10	Carbon steel	Indoor – air conditioned	None	None required
			Outdoor	Loss of material	Systems and Structures Monitoring Program
Stairs Platforms Grating	7	Carbon steel Carbon steel – galvanized	Indoor – air conditioned	None	None required
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Indoor – air conditioned	None	None required
Safety-related supports (pipe supports and component supports)	2, 10	Carbon steel	Indoor – air conditioned	None	None required
Non-safety related supports	7, 10	Carbon steel	Indoor – air conditioned	None	None required
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Indoor – air conditioned	None	None required

TABLE 3.6-5 (continued)
CONTROL BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Cable tray and conduit supports	2, 7, 10	Carbon steel Carbon steel – galvanized	Indoor – air conditioned	None	None required
Electrical enclosures (includes control panels)	2, 3, 7, 10	Carbon steel Carbon steel – galvanized Stainless steel	Indoor – air conditioned	None	None required
Electrical component supports	2, 7, 10	Carbon steel Carbon steel – galvanized	Indoor – air conditioned	None	None required
Instrument racks and frames	2, 7, 10	Carbon steel Carbon steel – galvanized	Indoor – air conditioned	None	None required
HVAC supports	2, 7, 10	Carbon steel Carbon steel – galvanized	Indoor – air conditioned	None	None required
Reinforced concrete: Foundations (above groundwater elevation)	2, 7, 10	Concrete	Buried	None	None required

TABLE 3.6-5 (continued)
CONTROL BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Reinforced concrete: Beams Columns Walls Floors/Slabs (above groundwater elevation)	2, 3, 4, 6, 7, 10	Concrete	Outdoor Indoor – air conditioned	None	None required
Reinforced masonry block walls	2, 3, 4, 6, 7, 10	Concrete	Indoor – air conditioned	None	None required
Unreinforced masonry block walls	2, 3, 4, 6, 7, 10	Concrete	Indoor – air conditioned	Cracking	Systems and Structures Monitoring Program
Anchorages/ embedments	2, 7, 10	Steel	Embedded/Encased	None	None required
Control Room ceiling	7	Gypsum board Acoustical panels	Indoor – air conditioned	None	None required
Control Room raised floor	7	Tee cor panel Micarta Cove base Steel supports	Indoor – air conditioned	None	None required
Weatherproofing	3	Caulking/sealant Roofing material	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program

TABLE 3.6-6
COOLING WATER CANALS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Earthen canal	5	Earth/rock	Outdoor	None	None required

TABLE 3.6-7
DIESEL DRIVEN FIRE PUMP ENCLOSURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Anchorages/ embedments exposed surfaces	10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Reinforced concrete foundations (above groundwater elevation)	10	Concrete	Buried	None	None required
Anchorages/ embedments (above groundwater elevation)	10	Carbon steel Carbon steel – galvanized	Embedded/Encased	None	None required
Pipe supports	10	Carbon steel	Indoor – not air conditioned	Loss of material	Systems and Structures Monitoring Program
Manufactured structure	10	Steel Aluminum	Outdoor	Loss of seal	Systems and Structures Monitoring Program
Doors	10	Aluminum	Outdoor	None	None required
Louvers	10	Aluminum	Outdoor	None	None required

TABLE 3.6-8
DISCHARGE STRUCTURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete: North pipe headwall	7	Concrete	Raw water – cooling canals (submerged or exposed to splash)	Loss of material Change in material properties	Systems and Structures Monitoring Program
			Outdoor	None	None required
Reinforced concrete: South pipe headwall	7	Concrete	Raw water – cooling canals (submerged or exposed to splash)	Loss of material Change in material properties	Systems and Structures Monitoring Program
			Outdoor	None	None required

TABLE 3.6-9
ELECTRICAL PENETRATION ROOMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Cable trays Conduits	2, 3, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Cable trays and conduits supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Electrical enclosures	2, 3, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Electrical component supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required

TABLE 3.6-9 (continued)
ELECTRICAL PENETRATION ROOMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Instrument racks	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
Structural steel	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
Ladders Platforms	7	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Reinforced concrete: Foundations (above groundwater elevation)	2, 7, 10	Concrete	Outdoor Buried	None	None required
Reinforced concrete: (above groundwater elevation) Walls Floors Roof	2, 3, 4, 6, 7, 10	Concrete	Indoor - not air conditioned Outdoor	None	None required
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	None	None required

TABLE 3.6-9 (continued)
ELECTRICAL PENETRATION ROOMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Weatherproofing	3	Caulking/sealant Membrane roof with concrete topping Flashing	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program

TABLE 3.6-10
EMERGENCY DIESEL GENERATOR BUILDINGS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Structural steel: Beams Columns Connections	2, 6, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
Miscellaneous steel	2, 3, 6, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
Stairs Platforms Grating	7	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor – air conditioned Indoor - not air conditioned	None	None required
		Stainless steel	Indoor - not air conditioned	None	None required

TABLE 3.6-10 (continued)
EMERGENCY DIESEL GENERATOR BUILDINGS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor – air conditioned Indoor - not air conditioned	None	None required
Safety-related supports (pipe supports and component supports)	2, 10	Carbon steel	Indoor - not air conditioned	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
Non-safety related pipe supports	7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
Non-safety related pipe segments between class break and seismic anchor	2, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor - not air conditioned	None	None required
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required

TABLE 3.6-10 (continued)
EMERGENCY DIESEL GENERATOR BUILDINGS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Cable tray and conduit supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Indoor – air conditioned	None	None required
Electrical component supports	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
Electrical enclosures	2, 3, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
		Carbon steel	Indoor – air conditioned	None	None required
		Carbon steel – galvanized Stainless steel	Indoor - not air conditioned Indoor – air conditioned	None	None required

TABLE 3.6-10 (continued)
EMERGENCY DIESEL GENERATOR BUILDINGS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Instrument racks and frames	2, 7, 10	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized Stainless steel	Indoor - not air conditioned Indoor – air conditioned	None	None required
HVAC supports	2, 7, 10	Carbon steel	Indoor - not air conditioned Outdoor	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Outdoor	None	None required
HVAC roof hoods (Unit 4)	2, 7, 10	Stainless steel	Outdoor	None	None required
Reinforced concrete: Foundations (above groundwater elevation)	2, 7, 10	Concrete	Buried	None	None required

TABLE 3.6-10 (continued)
EMERGENCY DIESEL GENERATOR BUILDINGS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Reinforced concrete: (above groundwater elevation) Beams Columns Walls Floor/slabs	2, 3, 4, 6, 7, 8, 10	Concrete	Indoor - not air conditioned Outdoor	None	None required
Reinforced masonry block walls	2, 3, 4, 6, 7, 8, 10	Concrete	Indoor - not air conditioned Outdoor	None	None required
Unreinforced masonry block walls	2, 3, 4, 6, 7, 8, 10	Concrete	Indoor - not air conditioned	Cracking	Systems and Structures Monitoring Program
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	None	None required
Weatherproofing	3	Chase foam Silicone Caulking	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program
Louvers	3	Aluminum	Outdoor	None	None required

TABLE 3.6-11
FIRE PROTECTION MONITORING STATION

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Structural steel roof support	10	Carbon steel	Indoor - air conditioned	None	None required
Anchorages/ embedments exposed surfaces	10	Carbon steel Carbon steel - galvanized	Indoor - air conditioned	None	None required
Reinforced concrete floor and roof	10	Concrete	Outdoor Indoor – air conditioned	None	None required
Unreinforced masonry block walls	10	Concrete	Outdoor Indoor - air conditioned	Cracking	Systems and Structures Monitoring Program
Anchorages/ embedments (above groundwater elevation)	10	Carbon steel	Embedded/Encased	None	None required
Doors	10	Aluminum	Outdoor Indoor - air conditioned	None	None required
Membrane roof	10	W.R. Grace membrane roofing system	Outdoor	None	None required

TABLE 3.6-12 [1]
FIRE RATED ASSEMBLIES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fire Barriers					
Raceway fireproofing protection	4	Thermo-Lag 3M Interam FireDam Caulk Marinite board Cerafiber Quelpyre mastic Silicone foam Flamemastic	Outdoor	Loss of material	Fire Protection Program
			Indoor - not air conditioned Indoor – air conditioned	None	None required
Fire retardant coating	4	Flamemastic	Indoor - not air conditioned Indoor – air conditioned	None	None required
Structural steel fireproofing	4	Cementitious fireproofing	Indoor - not air conditioned Indoor – air conditioned	None	None required
Manhole seals	4	Sealant	Outdoor	Loss of seal	Fire Protection Program

NOTE: 1. Concrete and steel structural components that serve as fire rated barriers are addressed with each structure. Radiant energy shields are addressed with the Containments.

TABLE 3.6-12 (continued)
FIRE RATED ASSEMBLIES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fire Barriers (continued)					
Fire sealed isolation joint	4	Cerafiber	Outdoor	Loss of seal	Fire Protection Program
Fire doors	4	Carbon steel	Indoor - air conditioned	None	None required
			Outdoor Indoor – not air conditioned	Loss of material	Fire Protection Program
Control Room fire doors	3, 4	Carbon steel	Indoor - air conditioned	None	None required
			Outdoor	Loss of material	Fire Protection Program

TABLE 3.6-12 (continued)
FIRE RATED ASSEMBLIES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fire Seals					
Type M-1 mechanical penetration seals	4	Silicone elastomer	Indoor - not air conditioned Indoor – air conditioned	None	None required
Type M-4 sheet metal sleeve extensions	4	Sheet metal sleeve			
Type M-8 mechanical penetration seals	4	Silicone foam			
Type M-11 penetration requiring movement	4	Silicone elastomer Sheet metal sleeve			
Type M-15 boot and fiber	4	Cerafiber and boot Sheet metal sleeve			
Type E-1 electrical penetration seal	4	Silicone elastomer	Indoor - not air conditioned Indoor – air conditioned	None	None required
Type E-16 wireway through an I-beam web	4	Silicone elastomer			
Type EM-1 boxing detail	4	Carbon steel – galvanized			
Type M-18 instrument tubing penetration seal	4	Hydrosil			
Type M-3 mechanical penetration seal	4	High density gel			

TABLE 3.6-12 (continued)
FIRE RATED ASSEMBLIES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fire Seals (continued)					
PVC conduit	4	Silicone foam	Indoor - not air conditioned Indoor – air conditioned	None	None required
Type GFS penetration seal	4	OZ Gedney fireseal			
Type CF penetration seal	4	Ceramic fiber			
Type CLK penetration seal	4	Cerafiber with caulk			
Type foam penetration seal	4	Silicone foam			
Open ended conduit (empty) Threaded metal cap	4	Carbon steel – galvanized	Indoor - not air conditioned Indoor – air conditioned	None	None required
Electrical conduit seal	4	Silicone RTV foam	Indoor – not air conditioned Indoor – air conditioned	None	None required

TABLE 3.6-13
INTAKE STRUCTURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Structural steel: Beams Columns Connections	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Stairs Platforms Grating	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized Stainless steel	Outdoor	None	None required
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor - wetted		
		Carbon steel – galvanized	Outdoor	None	None required
Non-safety related supports	7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Non-safety related pipe segments between class break and seismic anchor	2, 10	Stainless steel	Outdoor	None	None required

TABLE 3.6-13 (continued)
INTAKE STRUCTURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Outdoor	None	None required
			Outdoor – wetted	Loss of material	Systems and Structures Monitoring Program
Cable tray and conduit supports	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor – wetted		
		Carbon steel – galvanized	Outdoor	None	None required
Electrical enclosures	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor – wetted		
		Carbon steel – galvanized Stainless steel	Outdoor	None	None required
Electrical component supports	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor - wetted		
		Carbon steel – galvanized	Outdoor	None	None required

TABLE 3.6-13 (continued)
INTAKE STRUCTURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Instrument racks and frames	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor - wetted		
		Carbon steel – galvanized	Outdoor	None	None required
Intake bridge crane	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Intake structure traveling screen frames	7	Carbon steel	Outdoor Raw water – cooling canals	Loss of material	Systems and Structures Monitoring Program
Intake structure traveling screen cloth	9	Stainless steel	Outdoor Raw water – cooling canals	Loss of material	Systems and Structures Monitoring Program
Reinforced concrete: Foundations Beams Columns Walls Floors/slabs (below intake canal level)	2, 5, 7, 10	Concrete	Raw water – cooling canals (submerged)	Loss of material Change in material properties	Systems and Structures Monitoring Program

TABLE 3.6-13 (continued)
INTAKE STRUCTURE

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete: Beams Columns Walls Floors/slabs (above intake canal level)	2, 5, 7, 8, 10	Concrete	Outdoor	None	None required
Anchorages/ embedments (below intake canal level)	2, 7, 10	Steel	Embedded/Encased	Loss of material	Systems and Structures Monitoring Program
Anchorages/ embedments (above intake canal level)	2, 7, 8, 10	Steel	Embedded/Encased	None	None required

TABLE 3.6-14
MAIN STEAM AND FEEDWATER PLATFORMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Structural steel: Beams Columns Connections	2, 6, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Stairs Platforms Grating	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Safety-related supports (pipe and component supports)	2, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Non-safety related supports	7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Pipe whip restraints	11	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Outdoor	None	None required

TABLE 3.6-14 (continued)
MAIN STEAM AND FEEDWATER PLATFORMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Cable tray and conduit supports	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Electrical enclosures	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized Stainless steel	Outdoor	None	None required
Electrical component supports	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Instrument racks and frames	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Reinforced concrete foundations (above groundwater elevation)	2, 7, 10	Concrete	Outdoor Buried	None	None required

TABLE 3.6-14 (continued)
MAIN STEAM AND FEEDWATER PLATFORMS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Reinforced concrete: (above groundwater elevation) Walls Floors Roof	2, 3, 6, 7, 10	Concrete	Outdoor	None	None required
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	None	None required

TABLE 3.6-15
PLANT VENT STACK

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Structural steel supports/ restraints	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Anchorages/ embedments exposed surfaces	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel - galvanized	Outdoor	None	None required
Conduits and conduit supports	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Electrical enclosures and supports	7	Carbon steel – galvanized Stainless steel	Outdoor	None	None required
Steel vent stack	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required

TABLE 3.6-15 (continued)
PLANT VENT STACK

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/ Activity
Pedestal and grout cover (above groundwater elevation)	7	Concrete	Outdoor Buried	None	None required
Anchorages/embedments (above groundwater elevation)	7	Carbon steel	Embedded/Encased	None	None required

TABLE 3.6-16
SPENT FUEL STORAGE AND HANDLING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Manipulator cranes	2	Carbon steel	Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Spent fuel bridge cranes	2	Carbon steel	Indoor - not air conditioned	Loss of material	Systems and Structures Monitoring Program
Spent fuel cask crane	2	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Fuel transfer sheave frames	2	Carbon steel	Indoor - not air conditioned Containment air	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Spent fuel pools, transfer canals, and refueling pool liners keyway gates embedded plates	1	Stainless steel	Containment air Indoor - not air conditioned	None	None required
			Treated water – borated	Loss of material	Chemistry Control Program

TABLE 3.6-16 (continued)
SPENT FUEL STORAGE AND HANDLING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Fuel transfer tubes Fuel transfer tube penetration sleeves Fuel transfer tube gate valves	1[1]	Stainless steel	Containment air Indoor - not air conditioned (internal and external surfaces)	None	None required
			Treated water – borated (internal and external surfaces)	Loss of material	Chemistry Control Program
		Carbon steel	Embedded/Encased	None	None required
Spent fuel handling equipment and tools	2	Stainless steel	Containment air	None	None required
			Treated water – borated	Loss of material	Chemistry Control Program
Reactor cavity seal rings	1	Stainless steel	Containment air	None	None required
			Treated water – borated	Loss of material	Chemistry Control Program
Spent fuel storage racks	2	Stainless steel	Treated water – borated	Loss of material	Chemistry Control Program

NOTE: 1. The pressure boundary function of the portion of the fuel transfer tubes inside Containment and the penetration sleeves is related to Containment integrity. The pressure boundary function of the portion of the fuel transfer tubes outside Containment and the fuel transfer tube gate valves is spent fuel pool integrity when the spent fuel pool keyway gates are removed during fuel handling.

TABLE 3.6-16 (continued)
SPENT FUEL STORAGE AND HANDLING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Boraflex	3	Boron impregnated polymer	Treated water – borated	Change in material properties	Boraflex Surveillance Program
Reinforced concrete overhead sliding doors	3, 4, 6	Concrete	Outdoor	None	None required

TABLE 3.6-17
TURBINE BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Outdoor Indoor – air conditioned	None	None required
Structural steel and miscellaneous steel (including stairs, platforms and grating)	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Non-safety related supports	7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Non-safety related pipe segments between class break and seismic anchor	2, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Outdoor Indoor – air conditioned	None	None required

TABLE 3.6-17 (continued)
TURBINE BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Cable tray and conduit supports	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Outdoor Indoor – air conditioned	None	None required
Electrical enclosures	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Outdoor Indoor – air conditioned	None	None required
		Stainless steel	Outdoor	None	None required
Electrical component supports	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Indoor – air conditioned	None	None required
		Carbon steel – galvanized	Outdoor Indoor – air conditioned	None	None required

TABLE 3.6-17 (continued)
TURBINE BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Instrument rack and frames	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Reinforced concrete: Foundations (including switchgear/load center enclosures)	2, 4, 6, 7, 10	Concrete	Buried	None	None required
Reinforced concrete: Walls Floors Roof (including switchgear/load center enclosures)	2, 3, 4, 6, 7, 10	Concrete	Outdoor Indoor – air conditioned	None	None required
Reinforced masonry block walls (above groundwater elevation)	2, 3, 4, 7, 10	Concrete	Indoor – air conditioned	None	None required
Unreinforced masonry block walls	2, 3, 4, 7, 10	Concrete	Outdoor	Cracking	Systems and Structures Monitoring Program
Perimeter flood walls	8	Concrete	Outdoor	None	None required
Anchorages/ embedments	2, 7, 10	Steel	Embedded/Encased	None	None required
Weatherproofing	3	Pourable caulking Polymer sealant	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program

TABLE 3.6-17 (continued)
TURBINE BUILDING

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Pipe trench penetrations	8	Promatec flexible seal	Outdoor	Loss of seal	Periodic Surveillance and Preventive Maintenance Program
Stop logs	8	Wood	Outdoor	Loss of material	Periodic Surveillance and Preventive Maintenance Program
		Aluminum	Outdoor	None	None required

TABLE 3.6-18
TURBINE GANTRY CRANES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Runway rails Rail anchorages/ embedments Leg truck beams Leg end frames Main girders Cab Ladders and stairways Platforms Railings Trolley rails Trolley structure	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Electrical enclosures	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required

TABLE 3.6-19
TURKEY POINT UNITS 1 AND 2 CHIMNEYS

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete chimney	7	Concrete	Outdoor	None	None required
Reinforced concrete foundations (above groundwater elevation)	7	Concrete	Buried	None	None required

TABLE 3.6-20
YARD STRUCTURES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Anchorages/ embedments exposed surfaces	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Miscellaneous steel	7	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Carbon steel – galvanized	Outdoor	None	None required
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Safety-related supports (pipe supports and component supports)	2, 10	Carbon steel	Outdoor	Loss of material	ASME Section XI, Subsection IWF Inservice Inspection Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Non-safety related pipe segments between class break and seismic anchor	2	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
		Stainless steel	Outdoor	None	None required

TABLE 3.6-20 (continued)
YARD STRUCTURES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Non-safety related supports	7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Cable trays Conduits	2, 3, 7, 10	Carbon steel – galvanized	Outdoor	None	None required
			Outdoor - wetted	Loss of material	Systems and Structures Monitoring Program
			Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Cable tray, conduit and electrical supports	2, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor – wetted	Loss of material	Systems and Structures Monitoring Program
			Outdoor	None	None required
		Carbon steel Carbon steel – galvanized	Borated water leaks	Loss of material	Boric Acid Wastage Surveillance Program
Electrical enclosures	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program

TABLE 3.6-20 (continued)
YARD STRUCTURES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Instrument racks and frames	2, 3, 7, 10	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
		Carbon steel – galvanized	Outdoor	None	None required
Pipe whip restraints	11	Carbon steel	Outdoor	Loss of material	Systems and Structures Monitoring Program
Reinforced concrete foundations: (above groundwater elevation) 3A and 3B emergency diesel generator fuel oil transfer pumps Unit 3 emergency diesel generator fuel oil storage tank Refueling water storage tanks Condensate storage tanks Auxiliary feedwater pumps	2, 10	Concrete	Outdoor	None	None required

TABLE 3.6-20 (continued)
YARD STRUCTURES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete foundations: (above groundwater elevation) Demineralized water tank Diesel driven instrument air compressors Diesel driven standby steam generator feedwater pump Raw water tanks Diesel fire pump fuel storage tank Electric fire pump Fire water jockey pump	10	Concrete	Outdoor	None	None required
Reinforced concrete foundations for pipe supports (above groundwater elevation)	2, 7, 10	Concrete	Outdoor	None	None required
Reinforced concrete: Electrical duct banks Electrical manholes (above groundwater elevation)	3, 10	Concrete	Outdoor	None	None required

TABLE 3.6-20 (continued)
YARD STRUCTURES

Component/ Commodity Group	Intended Function (See Table 3.6-1)	Material	Environment	Aging Effects Requiring Management	Program/Activity
Reinforced concrete intake cooling water piping (above groundwater elevation)	7	Concrete	Buried	None	None required
Reinforced concrete pipe trenches (above groundwater elevation)	2, 10	Concrete	Outdoor	None	None required
Anchorages/ embedments (above groundwater elevation)	2, 7, 10	Steel	Embedded/Encased	None	None required

3.7 ELECTRICAL AND INSTRUMENTATION AND CONTROLS

Section 2.5 provides a description of the electrical/I&C components requiring aging management review for license renewal. This section provides the results of the aging management review of the electrical/I&C components. The results of this section are also summarized in Table 3.7-5.

3.7.1 AGING EFFECTS REQUIRING MANAGEMENT

3.7.1.1 NON-ENVIRONMENTALLY QUALIFIED INSULATED CABLES AND CONNECTIONS, AND ELECTRICAL/I&C PENETRATIONS

An evaluation published by the Department of Energy (DOE), "Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations" [Reference 3.7-1, (DOE Cable AMG)], provides a comprehensive compilation and evaluation of information on the topics of insulated cables and connections, spliced connections, and terminal blocks. The electrical/I&C non-metallic materials are evaluated with the cable and connector materials in this evaluation. The DOE Cable AMG evaluated the stressors acting on cable and connection components, industry data on aging and failure of these components, and the maintenance activities performed on cable systems. Also evaluated were the main subsystems within cables, including the conductors, insulation, shielding, tape wraps, and jacketing, as well as all subcomponents associated with each type of connection.

The principal aging mechanisms and anticipated effects resulting from environmental and operating stresses were identified, evaluated, and correlated with plant experience to determine whether the predicted effects are consistent with field experience. As such, the information, evaluations, and conclusions contained in the DOE Cable AMG are used for the evaluation of aging effects in this subsection.

The most significant and observed aging mechanisms for insulated cables and connections are listed in the DOE Cable AMG, Table 4-18. The aging mechanisms from that table are used in this subsection as the starting point for identifying aging effects for insulated cables and connections. The potential aging effects along with the applicable stressors that are evaluated for insulated cables and connections are presented in Table 3.7-1 and are discussed in the following subsections.

3.7.1.1.1 LOW-VOLTAGE METAL CONNECTOR CONTACT SURFACES — MOISTURE AND OXYGEN

The DOE Cable AMG, Section 3.7.2.1.3, states that 3% of all low-voltage metal connector failures were identified as being caused by moisture intrusion. In each case, the source of moisture was precipitation. Based on the total number of reported connector failures in the DOE Cable AMG, moisture intrusion accounted for only 10 failures in all of the operating plants in the United States.

Structures where electrical/I&C components may be exposed to moisture are indicated in Table 3.7-2. The potential moisture sources from Table 3.7-2 that are applicable to connectors at Turkey Point are precipitation and potential boric acid leaks. All metal connectors are located in enclosures or protected from the environment with Raychem splices. Thus, aging effects related to moisture and oxygen do not require management for low-voltage connectors at Turkey Point.

Note: Electrical enclosures are treated as structural components and are discussed with each structure, as applicable, in Section 3.6.

3.7.1.1.2 LOW-VOLTAGE METAL COMPRESSION FITTINGS — VIBRATION AND TENSILE STRESS

The aging mechanism of mechanical stress will not result in aging effects requiring management for the following reasons:

- Damage to cables during installation at Turkey Point is unlikely due to standard installation practices, which include limitations on cable pulling tension and bend radius. Even though installation damage is unlikely, most (including all safety related) cables are tested after installation and before operation. Failures induced by installation damage generally occur within a short time after the damaged cable is energized.
- NRC resolution of License Renewal Issue No.98-0013 [Reference 3.7-2], which states, "Based on the above evaluation, the staff concludes that the issue of degradation induced by human activities need not be considered as a separate aging effect and should be excluded from an aging management review."
- Mechanical stress due to forces associated with electrical faults is mitigated by the fast action of circuit protective devices at high currents. However, mechanical stress due to electrical faults is not considered an aging mechanism since such faults are infrequent and random in nature.
- Vibration is generally induced in cables and connections by the operation of external equipment, such as compressors, fans, and pumps. Vibration can affect cable connections at a running motor by producing fatigue damage of the metallic cable or termination components in the immediate vicinity of the connection point. Normally, there has to be some physical damage as well to have an effect (e.g., a nicked connector). Terminations at equipment are part of the equipment and are inspected and maintained along with the

equipment. These terminations are not within the evaluation boundary for insulated cable and connections and are not included in the insulated cable and connection review.

- Manipulation of cables is not considered an aging mechanism since such manipulation occurs during maintenance activities. Such activities require post-maintenance testing to detect any deficiencies in the cables. Any evidence of cable abnormalities would result in the condition being addressed under the corrective action program.

3.7.1.1.3 MEDIUM-VOLTAGE CABLE AND CONNECTIONS AND ELECTRICAL/I&C PENETRATION INSULATION — MOISTURE AND VOLTAGE STRESS

The DOE Cable AMG, Section 3.7.4, describes a survey of 25 fossil and nuclear power plants that was conducted to determine the number and types of medium-voltage cable failures that have occurred. The survey identified only 27 failures in almost 1000 plant-years of experience. The failures that occurred, other than moisture-produced water trees, were related to wetting in conjunction with manufacturing defects or damaged terminations due to improper installation, and were not related to aging effects.

Electrical/I&C penetrations are not located in structures exposed to outside ambient conditions and, therefore, not subjected to moisture.

Structures where electrical/I&C cable and connectors may be exposed to moisture are indicated in Table 3.7-2. The effects of moisture-produced water trees on medium-voltage cable were examined in Section 4.1.2.5 of the DOE Cable AMG. Water trees occur when the insulating materials are exposed to long-term, continuous electrical stress and moisture. These trees eventually result in breakdown of the dielectric materials and ultimate failure. The growth and propagation of water trees is somewhat unpredictable and few occurrences have been noted for cables operated below 15kV. Water treeing is a long-term degradation and failure phenomenon that is documented only for medium-voltage electrical cable with cross-linked polyethylene (XLPE) or high molecular weight polyethylene (HMWPE) insulation. However, some cables are located in structures exposed to outside ambient conditions and are evaluated for the potential of moisture-produced water trees.

Turkey Point Units 3 and 4 medium-voltage applications, defined as 2kV to 15kV, use lead sheath cable to prevent effects of moisture on the cables. In addition, Turkey Point does not use XLPE or HMWPE insulated cables in medium-voltage applications. Therefore, aging effects related to cable exposed to moisture and voltage stress do not require management at Turkey Point.

3.7.1.1.4 MEDIUM- AND LOW-VOLTAGE CABLE AND CONNECTIONS AND ELECTRICAL/I&C PENETRATION INSULATION — RADIATION AND OXYGEN

The DOE Cable AMG, Section 4.1.4, Table 4-7, provides a threshold value and a moderate dose for various insulating materials. The threshold value is the amount of radiation that causes incipient to mild insulation damage. Once this threshold is exceeded, damage to the insulation increases from mild to moderate to severe as the total dose increases. The moderate damage value indicates the value at which the insulating material has been damaged but is still functional. Turkey Point evaluations use the moderate damage dose from the DOE Cable AMG as the limiting radiation value shown in Table 3.7-3, unless otherwise noted in the table.

The maximum operating dose shown in Table 3.7-3 includes the maximum 60-year normal exposure for inside Containment. This is conservative, especially for cables located outside Containment.

A comparison of the maximum operating dose and the moderate damage doses in Table 3.7-3 shows that all of the insulation materials included in this aging management review will not exceed the moderate damage doses. Therefore, aging effects caused by radiation exposure will not adversely affect the intended function of insulated cables and connections and electrical/I&C penetrations during the extended period of operation. Therefore, aging effects related to radiation do not require management for cables and connections and electrical/I&C penetrations included in the aging management review.

3.7.1.1.5 MEDIUM- AND LOW-VOLTAGE CABLE AND CONNECTIONS AND ELECTRICAL/I&C PENETRATION INSULATION — HEAT AND OXYGEN

A maximum operating temperature was developed for each insulation type based on cable applications at Turkey Point Units 3 and 4. The maximum operating temperature indicated in Table 3.7-4 incorporates a conservative value for self-heating for power applications combined with the maximum design ambient temperature.

The Arrhenius method, as described in EPRI NP-1558, "A Review of Equipment Aging Theory and Technology" [Reference 3.7-3], was used to determine the maximum continuous temperature to which the insulation material can be exposed so that the material has an indicated "endpoint of 60 years." These limiting temperatures for 60 years of service are provided in Table 3.7-4.

A comparison of the maximum operating temperature to the maximum 60-year continuous use temperature for the various insulation materials indicates that, except for polyethylene (PE) and Butyl used in power applications, all of the insulation materials used in low- and medium-voltage power cables and connections can withstand the maximum operating temperatures for at least 60 years.

PE AND BUTYL CABLE INSULATION

The maximum operating temperatures, including self-heating, for PE and Butyl are 138.7°F and 132.6°F, respectively. The maximum temperatures for a 60-year life are 131.0°F for PE and 125.1°F for Butyl, which are 7.7°F and 7.5°F, respectively, less than the maximum operating temperatures. This difference is very small and is considered to be within the conservatisms incorporated in the maximum operating temperatures and the maximum 60-year continuous use temperatures, as discussed below.

Research funded by the NRC and published in NUREG/CR-6384, "Literature Review of Environmental Qualification of Safety-Related Electric Cables" [Reference 3.7-4], determined that the retention-of-elongation of most cable insulation materials can be reduced to 0% and the insulation will still be capable of withstanding a postulated loss-of-coolant accident (LOCA) and remain functional. In addition, preliminary results of environmental qualification research on low-voltage electrical cables were presented at a NRC public meeting on March 19, 1999. Preliminary conclusions from LOCA tests 1, 2, and 3 of the NRC research program indicate that, "Electric cables with insulation elongation-at-break values as low as 5% performed acceptably under accident conditions" [Reference 3.7-5]. Therefore, the maximum 60-year continuous use temperatures for typical cable insulation are significantly higher than the maximum temperatures shown in Table 3.7-4.

Butyl and PE insulated cables and connections are not used in containment and are not subjected to an accident environment. Therefore, the endpoints chosen for this aging management review are extremely conservative and the 60-year endpoint values can be reduced without a loss of function, thus resulting in higher maximum 60-year continuous use temperatures.

The maximum operating temperatures in Table 3.7-4 include a calculated self-heating temperature rise that assumes normal operation 100% of the time since receipt of the original operating licenses. In addition, as identified in Table 3.0-2, the actual daily and seasonal temperatures vary from 30°F – 95°F, which is less than the 104°F limit assumed in the calculation of 60-year lifetime for Butyl and PE. The Turkey Point units have historically operated less than 90% of the time since receipt of the original operating licenses. This amount of shutdown time lessens the amount of aging actually occurring and thus extends the lives of the materials.

Given these conservatisms, there is reasonable assurance that PE and Butyl insulated cables will not thermally age to the point at which they will not be able to perform their intended function during the period of extended operation. Aging effects related to heat and oxygen do not require management for cables and electrical/I&C penetrations included in the aging management review.

3.7.1.2 UNINSULATED GROUND CONDUCTORS

The ground cable material used at Turkey Point Units 3 and 4 is copper. Copper is a good choice for this application because of its high electrical conductivity, high fusing temperature, and high corrosion resistance. Copper is also relatively strong, and it is easy to join by welding, compression, or clamping. Ground connections are commonly made with welds or mechanical type connectors, which include compression-, bolted-, and wedge-type devices.

Review of available industry technical information regarding material aging revealed that there are no aging effects requiring management for copper grounding materials. In addition, a review of industry and plant operating experiences did not identify any failures of copper ground systems due to aging effects. Also, several underground portions of the Turkey Point grounding system were inspected during plant modifications to add two additional emergency diesel generators, in 1990 and 1991, and no aging-related effects were identified. The system was approximately 20 years old at the time of that inspection. The portion of the grounding system inspected is buried in the same type of soil as other underground portions of the grounding system. Therefore, based on industry and plant-specific experiences, no aging effects requiring management were identified for the plant grounding system.

3.7.2 OPERATING EXPERIENCE

3.7.2.1 INDUSTRY EXPERIENCE

The DOE Cable AMG review includes an industry-wide operating experience review of failures and aging effects of electrical cables and terminations. No aging effects were identified from the DOE Cable AMG beyond those already identified in Subsection 3.7.1.

An incident occurred at the Davis-Besse Nuclear Generating Station on October 2, 1999. A component cooling water pump tripped as a result of a phase-to-ground fault on a medium-voltage 3-phase power cable. The cable was installed in a 4-inch polyvinyl chloride (PVC) conduit, which runs partially underground, and had been in service for about 23 years.

As noted above, all medium-voltage applications (2kV to 15kV) at Turkey Point use lead sheath cable to prevent the effects of moisture on the cables. Based on Turkey Point's medium-voltage cable design, this incident is not applicable to medium-voltage cables at Turkey Point.

3.7.2.2 PLANT-SPECIFIC EXPERIENCE

Turkey Point Units 3 and 4 operating experience was reviewed to validate the identified aging effects requiring management. This review included a survey of Turkey Point non-conformance reports, licensee event reports, and condition reports for any documented instances of electrical/I&C component aging, in addition to interviews with responsible engineering personnel. No aging effects were identified from this review beyond those identified in Subsection 3.7.1. In particular, the review did not identify any instances where insulated cables or connections have failed due to heat-, radiation-, or moisture-related aging effects.

3.7.3 CONCLUSION

The review of industry information, NRC generic communications, and Turkey Point Units 3 and 4 operating experience identified no additional aging effects beyond those discussed in Subsection 3.7.1. Table 3.7-5 contains the results of the aging management review for electrical/I&C components and summarizes that there are no aging effects requiring management for electrical/I&C components. Based on the aging management review, the intended functions of electrical/I&C components will be maintained consistent with the current licensing basis for the period of extended operation.

3.7.4 REFERENCES

3.7-1 SAND 96-0344, "Aging Management Guideline for Commercial Nuclear Power Plants - Electrical Cable and Terminations," Sandia National Laboratories for the U. S. Department of Energy, September 1996.

3.7-2 C. I. Grimes (NRC) letter to D. J. Walter (NEI), "License Renewal Issue No. 98-0013, Degradation Induced Human Activities," June 5, 1998.

3.7-3 EPRI NP-1558, "A Review of Equipment Aging Theory and Technology," Electric Power Research Institute, September 1980.

3.7-4 NUREG/CR-6384, "Literature Review of Environmental Qualification of Safety-Related Electric Cables," Vol. 1, Brookhaven National Laboratory for the U.S. Nuclear Regulatory Commission, April 1996.

3.7-5 NRC Public Meeting Handouts, Presented by Brookhaven National Laboratory, "Environmental Qualification Research on Low-Voltage Electric Cables," Sponsored by the U.S. NRC, Office of Nuclear Regulatory Research, March 19, 1999.

TABLE 3.7-1
POTENTIAL AGING EFFECTS
ADAPTED FROM DOE CABLE AMG TABLE 4-18

Voltage Category[1]	Component	Applicable Stressor	Potential Aging Effects
Low voltage	Metal connector contact surfaces	Moisture and oxygen	Increased resistance and heating; loss of circuit continuity
	Compression fitting	Vibration Tensile stress	Loss of circuit continuity High resistance
Medium voltage	Cable and connections, electrical/I&C penetration insulation	Moisture and voltage stress	Electrical failure (breakdown of insulation)
Medium and low voltage	Cable and connections, electrical/I&C penetration insulation	Radiation and oxygen	Reduced insulation resistance; electrical failure
		Heat and oxygen	Reduced insulation resistance; electrical failure

NOTE: 1. Low Voltage: less than 2kV; Medium Voltage: 2kV to 15kV

TABLE 3.7-2
MOISTURE EXPOSURE SOURCES

Structure	Environment	Potential Moisture Exposure Source
Turbine Building Intake Structure Main Steam and Feedwater Platforms Yard Structures	Outdoor	Precipitation
Yard Structures	Indoor – not air conditioned (wetted)	Standing water in cable trenches
	Buried	Surface water drainage and soil moisture
Containments Auxiliary Building Yard Structures	Borated water leaks	Systems containing boric acid

TABLE 3.7-3
INSULATION MATERIAL
RADIATION EXPOSURE COMPARISON

Insulation Material	Maximum Operating Dose	Moderate Damage Dose	Additional Information
EP, EPR, FR, FR2, FR3, EPDM, FR-EPR	5.26 x 10^5 rads	5 x 10^7 rads	
Epoxy	5.26 x 10^5 rads	8 x 10^{16} rads	
Fiberglass (Mineral Insulated)	5.26 x 10^5 rads	None	Fiberglass is spun glass and, except for some changes in color, is not affected by radiation.
Kerite-HTK	5.26 x 10^5 rads	1 x 10^8 rads	Although no value for Kerite is listed in DOE Cable AMG, Table 4-7, the insulation material has been tested many times for the nuclear industry at total doses in excess of 1 x 10^8 rads. This value is used as the moderate damage dose.
Phenolic	5.26 x 10^5 rads	~4 x 10^7 rads	The radiation resistance of phenolic varies depending on what it is "filled" with (e.g., glass, asbestos). The values for "unfilled" phenolic are chosen since it is the weakest.
Silicon rubber	5.26 x 10^5 rads	3 x 10^6 rads	Silicone rubber is only used in electrical/I&C penetration pigtail cable insulation.
XLP, XLPE, FR-XLPE, Vulkene	5.26 x 10^5 rads	1 x 10^8 rads	
Butyl	5.26 x 10^5 rads	5 x 10^6 rads	
Hypalon	5.26 x 10^5 rads	2 x 10^6 rads	
Kapton	5.26 x 10^5 rads	2 x 10^8 rads	
Nylon	5.26 x 10^5 rads	2 x 10^6 rads	There are many formulations of nylon, a material originally developed by the DuPont Company. The values used here are for the most common formulation (general purpose) of nylon that is referred to as Nylon 66 and is designated Zytel 101. Zytel is the DuPont trademark for many different nylon resins.
PE	5.26 x 10^5 rads	2 x 10^7 rads	
PVC	5.26 x 10^5 rads	2 x 10^7 rads	
Micatemp – pressurizer heaters	5.26 x 10^5 rads	1 x 10^9 rads	

TABLE 3.7-4
INSULATION MATERIAL
TEMPERATURE EXPOSURE COMPARISON

Insulation Material	Maximum Operating Temperature [1]	Maximum Temperature For 60-Year Life	60-Year Endpoint
Phenolic	165.6°F (74.2°C)	220.5°F (104.7°C)	50% Retention of Impact Strength
XLPE	165.6°F (74.2°C)	188.1°F (86.7°C)	60% Retention-of-Elongation
Kapton	147.6°F (64.2°C)	248°F (120.0°C)	Failure
EPR, EPDM	147.6°F (64.2°C)	154.9°F (68.3°C)	40% Retention-of-Elongation
FR3	136.8°F (58.2°C)	166.6°F (74.8°C)	20% Retention-of-Elongation
Kerite-HTK	136.0°F (57.8°C)	185.4°F (85.2°C)	20% Retention-of-Elongation
PE	138.7°F (59.3°C)	131°F (55.0°C)	T_{75} Induction Period
Butyl	132.6°F (55.9°C)	125.1°F (51.7°C)	40% Retention-of-Elongation
FR	125.8°F (52.0°C)	141.5°F (60.8°C)	50% Retention-of-Elongation
EP	123.3°F (50.7°C)	154.9°F (68.3°C)	40% Retention-of-Elongation
Epoxy	122.0°F (50.0°C)	399.2°F (204.0°C)	50% Retention of Impact Strength
Silicon rubber	122.0°F (50.0°C)	273°F (133.9°C)	50% Retention-of-Elongation
Vulkene	122.0°F (50.0°C)	188.1°F (86.7°C)	60% Retention-of-Elongation
FR2	122.0°F (50.0°C)	192.5°F (89.2°C)	20% Retention-of-Elongation
FR-EP	122.0°F (50.0°C)	154.9°F (68.3°C)	40% Retention-of-Elongation
XLP, FR-XLPE	104.0°F (40.0°C)	188.1°F (86.7°C)	60% Retention-of-Elongation
Nylon	104.0°F (40.0°C)	129.9°F (54.4°C)	28% Retention of Tensile Strength
PVC	104.0°F (40.0°C)	112.0°F (44.4°C)	Mean-Time-To-Failure
Hypalon	104.0°F (40.0°C)	154°F (67.8°C)	50% Retention-of-Elongation
Fiberglass, Micatemp-PHC	Not required	Does not age from heat	Not applicable

NOTE: 1. Includes applicable self-heating temperature rise.

TABLE 3.7-5
ELECTRICAL/I&C COMPONENTS AGING MANAGEMENT REVIEW SUMMARY

Component / Commodity Group	Intended Function	Insulation Material	Environment [1]	Aging Effect Requiring Management	Program/Activity
Non-environmentally qualified cables and connections, and electrical/I&C penetrations (electrical power circuits)	To electrically connect specified sections of an electrical circuit to deliver voltage, current, or signal	Butyl, EP, EPR, EPDM, FR, FR2, FR3, Kapton, PE, Kerite-HTK, XLPE, Phenolic, Micatemp-PHC, Epoxy, and Silicone rubber	Moisture Temperature Elevated Temperature Ohmic Heating Radiation	None	None required
Non-environmentally qualified cables and connections, and electrical/I&C penetrations (instrumentation and control circuits)	To electrically connect specified sections of an electrical circuit to deliver voltage, current, or signal	Butyl, EP, EPR, EPDM, FR, FR2, FR3, FR-EPR, Nylon, Fiberglass, Hypalon, Kapton, PE Kerite-HTK, Phenolic, PVC, XLP, XLPE, Vulkene, FR-XLPE, Epoxy, and Silicone rubber	Moisture Temperature Elevated Temperature Radiation	None	None required
Uninsulated ground conductors	To electrically connect specified sections of an electrical circuit to deliver voltage, current, or signal	Uninsulated copper	Moisture Temperature Elevated Temperature Radiation	None	None required

NOTE: 1. All environments are external except ohmic heating, which is considered an internal environment.

4.0 TIME-LIMITED AGING ANALYSES

Two areas of technical review are required to support an application for a renewed operating license. The first area of technical review is the Turkey Point Integrated Plant Assessment, which is described in Chapters 2 and 3. The second area of technical review required for license renewal is the identification and evaluation of plant-specific time-limited aging analyses and exemptions, which are provided in this chapter. The evaluations included in this chapter meet the requirements contained in 10 CFR 54.21(c) and allow the NRC to make the finding contained in 10 CFR 54.29(a)(2).

4.1 IDENTIFICATION OF TIME-LIMITED AGING ANALYSES

10 CFR 54.21(c) requires an evaluation of time-limited aging analyses be provided as part of the application for a renewed license. Time-limited aging analyses are defined in 10 CFR 54.3 as those licensee calculations and analyses that:

(1) Involve systems, structures, and components within the scope of license renewal, as delineated in 10 CFR 54.4(a);

(2) Consider the effects of aging;

(3) Involve time-limited assumptions defined by the current operating term, for example, 40 years;

(4) Were determined to be relevant by the licensee in making a safety determination;

(5) Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, and component to perform its intended functions, as delineated in 10 CFR 54.4(b); and

(6) Are contained or incorporated by reference in the current licensing basis.

4.1.1 TIME-LIMITED AGING ANALYSES IDENTIFICATION PROCESS

The process used to identify the Turkey Point-specific time-limited aging analyses is consistent with the guidance provided in NEI 95-10, "Industry Guidelines for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule" [Reference 4.1-1]. Calculations and evaluations that meet the six criteria of 10 CFR 54.3 were identified from the Technical Specifications, UFSAR, docketed licensing correspondence, and applicable Westinghouse WCAPs. The calculations and evaluations that meet all six criteria of 10 CFR 54.3 are the Turkey Point-specific time-limited aging analyses listed in Table 4.1-1.

As required by 10 CFR 54.21(c)(1), an evaluation of Turkey Point-specific time-limited aging analyses must be performed to demonstrate that:

(i) the analyses remain valid for the period of extended operation;

(ii) the analyses have been projected to the end of the period of extended operation; or

(iii) the effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

The results of these evaluations are provided in Table 4.1-1 and discussed in Sections 4.2 through 4.7.

4.1.2 IDENTIFICATION OF EXEMPTIONS

The requirements at 10 CFR 54.21(c) also stipulate that the application for a renewed license include a list of plant-specific exemptions granted pursuant to 10 CFR 50.12 and in effect that are based on time-limited aging analyses as defined in 10 CFR 54.3. The identification was performed by evaluating the basis for each active 10 CFR 50.12 exemption to determine whether the exemption was based on a time-limited aging analysis. No 10 CFR 50.12 exemptions involving a time-limited aging analysis as defined in 10 CFR 54.3 were identified for Turkey Point Units 3 and 4.

4.1.3 REFERENCES

4.1-1 NEI 95-10, "Industry Guidelines for Implementing the Requirements of 10 CFR Part 54 – The License Renewal Rule," Revision 1, Nuclear Energy Institute, January 2000.

TABLE 4.1-1
TIME-LIMITED AGING ANALYSES

TLAA Category	Analysis	Resolution [10 CFR 54.21(c)(1) Section]	Section
Reactor Vessel Irradiation Embrittlement	Pressurized Thermal Shock	(ii) projected to the end of the period of extended operation	4.2.1
	Upper-Shelf Energy	(ii) projected to the end of the period of extended operation	4.2.2
	Pressure-Temperature Limits	(ii) projected to the end of the period of extended operation	4.2.3
Metal Fatigue	ASME Section III, Class 1 Components	(i) remains valid for the period of extended operation	4.3.1
	Reactor Vessel Underclad Cracking	(ii) projected to the end of the period of extended operation	4.3.2
	Reactor Coolant Pump Flywheel	(i) remains valid for the period of extended operation	4.3.3
	ANSI B31.1 Piping	(i) remains valid for the period of extended operation	4.3.4
Environmental Qualification	Anaconda Cables	(i) remains valid for the period of extended operation	4.4.1.1
	AIW Cables	(i) remains valid for the period of extended operation	4.4.1.2
	ASCO Solenoid Valves	(i) remains valid for the period of extended operation	4.4.1.3
	Brand Rex Coaxial Cables	(i) remains valid for the period of extended operation	4.4.1.4
	Brand Rex Instrument Cables	(i) remains valid for the period of extended operation	4.4.1.5
	Conax Conduit Seals	(i) remains valid for the period of extended operation	4.4.1.6
	Conax Penetrations	(i) remains valid for the period of extended operation	4.4.1.7
	Conax Unitized Resistance Temperature Detectors	(i) remains valid for the period of extended operation	4.4.1.8
	Champlain Cables	(i) remains valid for the period of extended operation	4.4.1.9
	Crouse Hinds Penetrations	(i) remains valid for the period of extended operation	4.4.1.10
	General Atomic Radiation Monitors	(i) remains valid for the period of extended operation	4.4.1.11
	General Cables	(i) remains valid for the period of extended operation	4.4.1.12

TABLE 4.1-1 (continued) TIME-LIMITED AGING ANALYSES

TLAA Category	Analysis	Resolution [10 CFR 54.21(c)(1) Section]	Section
Environmental Qualification (continued)	General Electric Cables	(i) remains valid for the period of extended operation	4.4.1.13
	General Electric Terminal Blocks	(i) remains valid for the period of extended operation	4.4.1.14
	Joy Emergency Containment Cooler and Emergency Containment Filtration Fan Motors	(i) remains valid for the period of extended operation	4.4.1.15
	Limitorque Valve Operators with Reliance Motors For Use Inside Containment	(i) remains valid for the period of extended operation	4.4.1.16
	Limitorque Valve Operators with Reliance Class H(RH) Insulation For Use Inside Containment	(i) remains valid for the period of extended operation	4.4.1.17
	Limitorque Valve Operators with Reliance Motors For Use Outside Containment	(i) remains valid for the period of extended operation	4.4.1.18
	Limitorque Valve Operators with Peerless Motors For Use Outside Containment	(i) remains valid for the period of extended operation	4.4.1.19
	Okonite Cables	(i) remains valid for the period of extended operation	4.4.1.20
	Raychem Heat Shrink Sleeving	(i) remains valid for the period of extended operation	4.4.1.21
	Raychem Cables	(i) remains valid for the period of extended operation	4.4.1.22
	MacWorth Rees Pushbutton Stations	(i) remains valid for the period of extended operation	4.4.1.23
	Rockbestos Cables	(i) remains valid for the period of extended operation	4.4.1.24
	Samuel Moore Cables	(ii) projected to the end of the period of extended operation	4.4.1.25
	3M Insulating Tape and Scotchfil	(i) remains valid for the period of extended operation	4.4.1.26
	Westinghouse Residual Heat Removal Pump Motors	(i) remains valid for the period of extended operation	4.4.1.27
	Westinghouse Containment Spray Pump Motors	(i) remains valid for the period of extended operation	4.4.1.28

TABLE 4.1-1 (continued)
TIME-LIMITED AGING ANALYSES

TLAA Category	Analysis	Resolution [10 CFR 54.21(c)(1) Section]	Section
Environmental Qualification (continued)	Westinghouse Safety Injection Pump Motors	(i) remains valid for the period of extended operation	4.4.1.29
	Combustion Engineering Mineral Insulated Cables and Connectors	(i) remains valid for the period of extended operation	4.4.1.30
	Kerite HTK/FR Cables	(i) remains valid for the period of extended operation	4.4.1.31
	Kerite FR2/FR Cables	(i) remains valid for the period of extended operation	4.4.1.32
	Kerite FR/FR Cables	(i) remains valid for the period of extended operation	4.4.1.33
	Kerite HTK/FR Power Cables	(i) remains valid for the period of extended operation	4.4.1.34
	Teledyne Thermatics Cables	(i) remains valid for the period of extended operation	4.4.1.35
	Weed Resistance Temperature Detectors	(i) remains valid for the period of extended operation	4.4.1.36
	Amerace NQB Terminal Blocks	(i) remains valid for the period of extended operation	4.4.1.37
	Patel/EGS Conformal Splices	(i) remains valid for the period of extended operation	4.4.1.38
	Patel/EGS Grayboot Connectors	(i) remains valid for the period of extended operation	4.4.1.39
Containment Tendon Loss of Prestress	Containment Tendon Loss of Prestress	(ii) projected to the end of the period of extended operation	4.5
Containment Liner Plate Fatigue	Containment Liner Plate Fatigue	(i) remains valid for the period of extended operation	4.6
Other Plant-Specific Time-Limited Aging Analyses	Bottom Mounted Instrumentation Thimble Tube Wear	(iii) the effects of aging on the intended function will be adequately managed for the period of extended operation	4.7.1
	Emergency Containment Cooler Tube Wear	(iii) the effects of aging on the intended function will be adequately managed for the period of extended operation	4.7.2
	Leak-Before-Break for Reactor Coolant System Piping	(ii) projected to the end of the period of extended operation	4.7.3
	Crane Load Cycle Limit	(i) remains valid for the period of extended operation	4.7.4

4.2 REACTOR VESSEL IRRADIATION EMBRITTLEMENT

This group of time-limited aging analyses concerns the effect of irradiation embrittlement on the belt-line regions of the Turkey Point Units 3 and 4 reactor vessels, and how this mechanism affects analyses that provide operating limits or address regulatory requirements. The calculations discussed in this section use predictions of the cumulative effects on the reactor vessels from irradiation embrittlement. The calculations are based on periodic assessment of the neutron fluence and resultant changes in the reactor vessel material fracture toughness.

The intermediate and lower shells and welds that join them in the beltline region (adjacent to the reactor core) of the reactor vessel are fabricated from low alloy steels. These ferritic steels exhibit a ductile-brittle transition that results in fracture toughness property changes as a function of both temperature and irradiation. The material property of particular importance in assessing reactor vessel integrity is fracture toughness, which can be defined as the capability of a material to resist sudden failure caused by crack propagation. Fracture toughness is reduced by neutron irradiation. The measure of fracture toughness of the reactor vessel materials when the reactor vessel is above the brittle fracture/ductile failure transition temperature is referred to as upper-shelf energy. Upper-shelf energy is related to the ability of a material to resist ductile tearing. In addition, the temperature at which the brittle fracture/ductile failure transition occurs increases with increasing radiation. This shift in the transition temperature is referred to as the shift in reference nil ductility transition temperature (RT_{NDT}).

The effect of embrittlement due to neutron bombardment is evaluated for reactor vessel temperatures throughout the range of normal operating values. Heatup and cooldown curves consider normal, relatively slow thermal transients. Pressurized thermal shock transients are characterized by a rapid and significant decrease in reactor coolant temperature with high pressure in the reactor vessel. The high reactor vessel thermal stresses, when combined with the pressure stresses, are assumed to initiate the propagation of a small flaw that is postulated to exist in the reactor vessel beltline. Postulated high pressures could cause propagation of the flaw through the reactor vessel wall.

The welds in the reactor vessel are basically the same material as the parts being joined and may be considered to be included in the preceding discussions. The chemistry differences between weld metal and base metal affect the material properties that are degraded by embrittlement; therefore, the welds are evaluated separately when considering the aforementioned aging effect.

4.2.1 PRESSURIZED THERMAL SHOCK

The requirements in 10 CFR 50.61 provide rules for protection against pressurized thermal shock events for pressurized water reactors. Licensees are required to perform an assessment of the projected values of the maximum nil ductility reference temperature (RT_{PTS}) whenever a significant change occurs in projected values of RT_{PTS}, or upon request for a change in the expiration date for the operation of the facility.

The methods for calculating RT_{PTS} values are given in 10 CFR 50.61 and are consistent with the methods in Regulatory Guide 1.99, "Radiation Embrittlement of Reactor Vessel Materials" [Reference 4.2-1]. These accepted methods were used to calculate the RT_{PTS} for the Turkey Point reactor vessel limiting materials at 48 effective full power years, the end of the license renewal period. The calculated RT_{PTS} values for the Turkey Point reactor vessels at the end of the period of extended operation (48 effective full power years) are:

	Unit 3	Unit 4
Lower Shell	108. 4°F	64.7°F
Intermediate Shell	78.3°F	129.4°F
Circumferential Weld	297.4°F	297.4°F

The calculated RT_{PTS} values at 48 effective full power years for the Turkey Point reactor vessels are less than the 10 CFR 50.61(b)(2) screening criteria of 270°F for intermediate and lower shells and 300°F for the circumferential welds. Based upon the revised calculations, additional measures will not be required for the Turkey Point reactor vessels during the license renewal period.

The analysis associated with pressurized thermal shock has been projected to the end of the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(ii).

4.2.2 UPPER-SHELF ENERGY

The requirements on reactor vessel Charpy upper-shelf energy are included in 10 CFR 50, Appendix G. Specifically, 10 CFR 50, Appendix G requires licensees to submit an analysis at least 3 years prior to the time that the upper-shelf energy of any of the reactor vessel material is predicted to drop below 50 ft-lb., as measured by Charpy V-notch specimen testing. The Turkey Point circumferential weld material previously fell below the 10 CFR 50, Appendix G, requirement of 50 ft-lb. At that time, a fracture mechanics evaluation was performed to demonstrate acceptable equivalent margins of safety against fracture. The NRC reviewed these evaluations, as documented in October 19, 1993 [Reference 4.2-2] and May 9, 1994 [Reference 4.2-3] letters to FPL. These references approved plant operation through the current license term (32 effective full power years).

A fracture mechanics evaluation was performed in accordance with Appendix K of ASME Section XI to demonstrate continued acceptable equivalent margins of safety against fracture through 48 effective full power years [Reference 4.2-4]. This evaluation concluded that the limiting weld for the Turkey Point reactor vessels satisfies the requirements of the ASME Boiler and Pressure Vessel Code, Section XI, Appendix K, for ductile flaw extension and tensile instability.

The analysis associated with upper-shelf energy has been projected to the end of the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(ii).

4.2.3 PRESSURE-TEMPERATURE LIMITS

The requirements in 10 CFR 50, Appendix G stipulate that heatup and cooldown of the reactor pressure vessel be accomplished within established pressure-temperature limits. These limits specify the maximum allowable pressure as a function of reactor coolant temperature. As the reactor pressure vessel becomes embrittled and its fracture toughness is reduced, the allowable pressure is reduced. Operation of the Reactor Coolant System is also limited by the net positive suction curves for the reactor coolant pumps. These curves specify the minimum pressure required to operate the reactor coolant pumps. Therefore, in order to heatup and cooldown, the reactor coolant temperature and pressure must be maintained within an operating window established between the Appendix G pressure-temperature limits and the net positive suction curves.

To address the period of extended operation, the 48 effective full power year projected fluences and the Turkey Point-specific reactor vessel material properties were used to determine the limiting material and calculate pressure-temperature limits for heatup and cooldown. The limiting material at all temperatures for the period of extended operation is the circumferential girth weld.

FPL has recently submitted to NRC a proposed license amendment for Turkey Point Units 3 and 4 to extend the service period for the pressure-temperature limit curves to a maximum of 32 effective full power years (EFPY), the end of the current license period [Reference 4.2-5]. The proposed license amendment also includes pressure-temperature limit and Low Temperature Overpressure Protection (LTOP) setpoints for 48 EFPY, the end of the period of extended operation. FPL has not requested NRC approval of the 48 EFPY pressure-temperature limit curves and LTOP setpoints at this time. A separate license amendment specifically requesting approval of the 48 EFPY pressure-temperature limit curves and LTOP setpoints will be submitted to the NRC in the future and prior to expiration of the proposed 32 EFPY pressure-temperature limit curves.

The analysis associated with reactor vessel pressure-temperature limit curves has been projected to the end of the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

4.2.4 REFERENCES

4.2-1 Regulatory Guide 1.99, Revision 2 , "Radiation Embrittlement of Reactor Vessel Materials," U.S. Nuclear Regulatory Commission, February 1986.

4.2-2 L. Raghavan (NRC) letter to J. H. Goldberg (FPL), "Turkey Point Units 3 and 4 - Review of Babcock and Wilcox Owners Group Materials Committee Reports - Upper-Shelf Energy," October 19, 1993.

4.2-3 Richard P. Croteau (NRC) letter to J. H. Goldberg (FPL), "Turkey Point Units 3 and 4 - Generic Letter (GL) 92-01, Revision 1, Reactor Vessel Structural Integrity," May 9, 1994.

4.2-4 BAW-2312, "Low Upper-Shelf Toughness Fracture Mechanics Analysis of Reactor Vessels of Turkey Point Units 3 and 4 for Extended Life Through 48 Effective Full Power Years," Babcock and Wilcox, November 1997.

4.2-5 R. J. Hovey (FPL) letter to U. S. Nuclear Regulatory Commission, "Revised Pressure-Temperature (P/T) Curves, and Cold Overpressure Mitigation System (CMOS) Setpoints," July 7, 2000.

4.3 METAL FATIGUE

The thermal and mechanical fatigue analyses of plant mechanical components have been identified as time-limited aging analyses for Turkey Point. Specific components have been designed considering transient cycle assumptions, as listed in vendor specifications and the Turkey Point UFSAR.

4.3.1 ASME BOILER AND PRESSURE VESSEL CODE, SECTION III, CLASS 1 COMPONENTS

The reactor vessels, reactor vessel internals, pressurizers, steam generators, reactor coolant pumps, and pressurizer surge lines have been designed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Class 1. The ASME Boiler and Pressure Vessel Code, Section III, Class 1 requires a design analysis to address fatigue and establish limits such that initiation of fatigue cracks is precluded.

Fatigue usage factors for critical locations in the Turkey Point Units 3 and 4 Nuclear Steam Supply System components were determined using design cycles that were specified in the plant design process. These design cycles were intended to be conservative and bounding for all foreseeable plant operational conditions. The design cycles were subsequently utilized in the design stress reports for various Nuclear Steam Supply System components satisfying ASME fatigue usage design requirements, and became part of the plant Technical Specifications.

Experience has shown that actual plant operation is often very conservatively represented by these design cycles. The use of actual operating history data allows the quantification of these conservatisms in the existing fatigue analyses. To demonstrate that the Class 1 component fatigue analyses remain valid for the period of extended operation, the design cycles applicable to the Class 1 components were assembled. The actual frequency of occurrence for the design basis cycles was determined and compared to the design cycle set. The severity of the actual plant transients was compared to the severity of the design cycles. This comparison was performed in order to demonstrate that on an event-by-event basis the design cycle profiles envelope actual plant operation. In addition, a review of the applicable administrative and operating procedures was performed to verify the effectiveness of the current design cycle counting program.

This review concluded that the existing design cycles and cycle frequencies are conservative and bounding for the period of extended operation.

The analyses associated with verifying the structural integrity of the reactor vessels, reactor vessel internals, pressurizers, steam generators, reactor coolant pumps, and pressurizer surge lines have been evaluated and determined to remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

For license renewal, continuation of the Turkey Point Fatigue Monitoring Program into the period of extended operation will assure that the design cycle limits are not exceeded. The Fatigue Monitoring Program is considered a confirmatory program and is described in Appendix B.

4.3.2 REACTOR VESSEL UNDERCLAD CRACKING

In early 1971, an anomaly identified as grain boundary separation, perpendicular to the direction of the cladding weld overlay, was identified in the heat-affected zone of reactor vessel base metal. A generic fracture mechanics evaluation demonstrated that the growth of underclad cracks during a 40-year plant life is insignificant.

The evaluation was extended to 60 years using fracture mechanics evaluations based on a representative set of design transients with the occurrences extrapolated to cover 60 years of service life. The 60-year evaluation shows insignificant growth of the underclad cracks.

The analysis associated with reactor vessel underclad crack growth has been projected to the end of the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

4.3.3 REACTOR COOLANT PUMP FLYWHEEL

During normal operation, the reactor coolant pump flywheel possesses sufficient kinetic energy to potentially produce high-energy missiles in the unlikely event of failure. Conditions which may result in overspeed of the reactor coolant pump increase both the potential for failure and the kinetic energy. The aging effect of concern is fatigue crack initiation in the flywheel bore keyway. An evaluation of the probability of failure over the extended period of operation was performed. It demonstrates that the flywheel design has a high structural reliability with a very high flaw tolerance and negligible flaw crack extension over a 60-year service life.

The analysis associated with the structural integrity of the reactor coolant pump flywheel has been evaluated and determined to remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.3.4 ANSI B31.1 PIPING

The Reactor Coolant System primary loop piping and balance-of-plant piping are designed to the requirements of ANSI B31.1, Power Piping. The exceptions are the Units 3 and 4 pressurizer surge lines and the Unit 4 Emergency Diesel Generator safety-related piping.

The pressurizer surge lines have been designed to the requirements of ASME Boiler and Pressure Vessel Code, Section III, Class 1 and are included in Subsection 4.3.1.

The Unit 4 Emergency Diesel Generator safety-related piping has been designed to the requirements of ASME Boiler and Pressure Vessel Code, Section III, Class 3, which is essentially the same as ANSI B31.1 design requirements. The evaluation of the Unit 4 Emergency Diesel Generator safety-related piping fatigue is, therefore, included in this subsection.

Design requirements in ANSI B31.1 assume a stress range reduction factor to provide conservatism in the piping design to account for fatigue due to thermal cyclic operation. This reduction factor is 1.0 provided the number of anticipated cycles is limited to 7000 equivalent full temperature cycles. This represents a condition where a piping system would have to be cycled approximately once every 3 days over the extended plant life of 60 years. Considering this limit, a review of the ANSI B31.1 piping within the scope of license renewal was performed in order to identify those systems that operate at elevated temperature and to establish their cyclic operating practices. Under current plant operating practices, piping systems within the scope of license renewal are only occasionally subject to cyclic operation. Typically these systems are subject to continuous steady-state operation and vary operating temperatures only during plant heatup and cooldown, during plant transients, or during periodic testing. The results of the evaluation for ANSI B31.1 piping systems demonstrate that the number of assumed thermal cycles will not be exceeded in 60 years of plant operation.

The analyses associated with ANSI B31.1 piping fatigue have been evaluated and determined to remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.3.5 ENVIRONMENTALLY ASSISTED FATIGUE

Generic Safety Issue (GSI) 190 [Reference 4.3-1], was identified by the NRC staff because of concerns about the potential effects of reactor water environments on Reactor Coolant System component fatigue life during the period of extended operation. GSI-190 was closed in December 1999 [Reference 4.3-2], and concluded that environmental effects have a negligible impact on core damage frequency, and as such, no generic regulatory action is required. However, as part of the closure of GSI-190, the NRC concluded that licensees who apply for license renewal should address the effects of coolant environment on component fatigue life as part of their aging management programs.

Fatigue calculations that include consideration of environmental effects to establish cumulative usage factors could be treated as time-limited aging analyses (TLAAs) under 10 CFR Part 54 or they could be utilized to establish the need for an aging management program. In other words, the determination of whether a particular component location is to be included in a program for managing the effects of fatigue, and the characteristics of that program, should incorporate reactor water environmental effects.

To qualify as a TLAA, the analysis of concern must satisfy all six criteria defined in 10 CFR 54.3. Failure to satisfy any one of these criteria eliminates the analysis from further consideration as a TLAA. Fatigue design for Turkey Point Units 3 and 4 has been determined to be a TLAA, even though the design limits are based on cycles rather than an explicit time period. However, reactor water environmental effects, as described in GSI-190, are not included in the Turkey Point current licensing basis (CLB), such that the criterion specified in 10 CFR 54.3(a)(6) is not satisfied. Nevertheless, environmental effects on Class 1 component fatigue have been evaluated separately for Turkey Point to determine if any additional actions are required for the period of extended operation.

The Turkey Point approach to address reactor water environmental effects accomplishes two objectives, as illustrated in Figure 4.3-1. First, the TLAA on fatigue design has been resolved by confirming that the original transient design limits remain valid for the 60-year operating period. Confirmation by the Fatigue Monitoring Program will ensure these transient design limits are not exceeded. Second, reactor water environmental effects on fatigue life are examined using the most recent data from laboratory simulation of the reactor coolant environment. These two aspects of fatigue design are kept separate, since fatigue design for

Turkey Point is part of the plant CLB and a TLAA, while the consideration of reactor water environmental effects on fatigue life, as described in GSI-190, is not considered part of the Turkey Point CLB.

It is important to note that there are three areas of margin included in the Turkey Point Fatigue Monitoring Program that are worthy of consideration. These areas include margins resulting from actual cycle experience, severity of transients, and moderate environmental effects.

Margin Due to Actual Cycles: It has been concluded that the original 40-year design transient set for Class 1 components is valid for the 60-year extended operating period. Conservative projections conclude that the design transient limits will not be exceeded. Additional margin is available in the current Class 1 component fatigue analyses since fatigue usage factors for all Class 1 components remain below the allowable value of 1.0.

Margin Due to Transient Severity: Much of the conservatism in the fatigue calculational methodology is due to design basis transient definitions. It has been concluded that the severity of the original Turkey Point design transients bounds actual plant operation. Additional industry fatigue studies [References 4.3-3 through 4.3-6] conclude that the fatigue impact of conservative design basis transient definitions by themselves bound the contributing impact of reactor water environmental effects.

Margin Due to Moderate Environmental Effects: A portion of the safety factors applied to the ASME Code Section III fatigue design curves includes moderate environmental effects. While there is debate over exactly how much margin this represents, it is noteworthy to recognize this safety factor in this qualitative discussion of margin.

Considering the three margins above, the Turkey Point Fatigue Monitoring Program is conservative from an overall perspective. Nevertheless, specific assessment of potential environmental effects on fatigue is addressed below.

As a part of the industry effort to address environmental effects for operating nuclear power plants during the current 40-year licensing term, Idaho National Engineering Laboratories (INEL) evaluated, in NUREG/CR-6260 [Reference 4.3-7], fatigue-sensitive component locations at plants designed by all four U. S. nuclear steam supply system vendors. The pressurized water reactor calculations, especially the early-vintage Westinghouse calculations, are directly relevant to Turkey Point. The description of the "Older Vintage Westinghouse Plant" evaluated in NUREG/CR-6260 matches Turkey Point with respect to design code. In addition, the transient cycles considered in the evaluation match or bound Turkey Point design.

The critical fatigue-sensitive component locations chosen in NUREG/CR-6260 for the early-vintage Westinghouse plant were:

1) The reactor vessel shell and lower head
2) The reactor vessel inlet and outlet nozzles
3) The pressurizer surge line (including the pressurizer and hot leg nozzles)
4) The Reactor Coolant System piping charging system nozzle
5) The Reactor Coolant System piping safety injection nozzle
6) The Residual Heat Removal System Class 1 piping

Note that for the latter three component locations, INEL performed representative design basis fatigue calculations, because early-vintage Westinghouse plants, including Turkey Point, utilize ANSI B31.1 design methodology for the majority of the Class 1 piping.

NUREG/CR-6260 calculated fatigue usage factors for these locations utilizing the interim fatigue curves provided in NUREG/CR-5999 [Reference 4.3-8]. The results of the NUREG/CR-6260 analyses were then utilized to scale up the Turkey Point plant-specific usage factors for the same locations to account for environmental effects. Generic industry studies performed by EPRI and NEI were also considered in this aspect of the evaluation [References 4.3-3 through 4.3-6], as well as environmental data that have been collected and published subsequent to the generic industry studies [References 4.3-9 and 4.3-10]. Based on these adjustments, only the pressurizer surge line piping required further evaluation for the period of extended operation. The pressurizer surge line piping is addressed below.

In lieu of additional analyses to refine the usage factor for the pressurizer surge line, Turkey Point has selected aging management to address pressurizer surge line fatigue during the period of extended operation. In particular, the potential for crack initiation and growth, including reactor water environmental effects, is adequately managed during the extended period of operation by the Turkey Point ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection Program.

The Turkey Point surge lines are 12-inch schedule 140 lines connected to the pressurizer surge nozzle at one end and to the hot leg surge line nozzle at the other end. The surge lines contain nine welds. A sample of these surge line welds is currently examined every ten years in accordance with the requirements of the ASME Section XI, Subsection IWB. Surge line welds selected for the inservice examinations, by nature of their size, require a volumetric examination. A number of the welds have been examined ultrasonically during the first three inservice examination intervals at Turkey Point, and a larger sample of welds is proposed to be examined ultrasonically during subsequent ten-year intervals. The increased sample of pressurizer surge line welds is based on the risk informed inservice inspection (RI-ISI) methodology. A request to revise the Unit 3 ASME Section XI, Subsection IWB inspection scope for Class 1 piping to RI-ISI has been submitted to the NRC [Reference 4.3-11]. Based on expert panel input into the Turkey Point Unit 3 RI-ISI proposal, which included consideration of environmental effects, the examination scope includes all of the pressurizer surge line welds. A similar change is proposed for Unit 4 and will be submitted to the NRC after approval of the Unit 3 submittal.

Pressurizer surge line examinations performed to date for Turkey Point Unit 3 include three surge line welds that have each been ultrasonically examined twice. For Turkey Point Unit 4, one weld has been ultrasonically examined three times, two welds have been ultrasonically examined twice, and an additional weld has been ultrasonically examined once. No reportable indications have been found.

Note that upon approval of the proposed RI-ISI programs for Turkey Point Units 3 and 4, all pressurizer surge line welds will be inspected during the fourth ISI interval and prior to the license renewal period. The results of these inspections will be utilized to assess the current 10-year inspection interval for continued use throughout the period of extended operation. As such, the potential effects of the reactor water environment have been evaluated for the extended period of operation as required by the resolution of GSI-190. The proposed RI-ISI enhancements to the ASME Section XI, Subsections IWB, IWC, and IWD Inservice Inspection Program provide reasonable assurance that potential environmental effects of fatigue will be managed such that components within the scope of license renewal will continue to perform their intended functions consistent with the current licensing basis for the extended period of operation.

4.3.6 REFERENCES

4.3-1 Generic Safety Issue 190, "Fatigue Evaluation of Metal Components for 60-Year Plant Life," U. S. Nuclear Regulatory Commission.

4.3-2 Memorandum, Ashok C. Thadani, Director, Office of Nuclear Regulatory Research, to William D. Travers, Executive Director of Operations – "Closeout of Generic Safety Issue 190, Fatigue Evaluation of Metal Components for 60 Year Plant Life," U. S. Nuclear Regulatory Commission, December 26, 1999.

4.3-3 EPRI Report No. TR-107515, "Evaluation of Thermal Fatigue Effects on Systems Requiring Aging Management Review for License Renewal for the Calvert Cliffs Nuclear Power Plant," Electric Power Research Institute, January 1998.

4.3-4 EPRI Report No. TR-110043, "Evaluation of Environmental Fatigue Effects for a Westinghouse Nuclear Power Plant," Electric Power Research Institute, April 1998.

4.3-5 EPRI Report No. TR-110356, "Evaluation of Environmental Thermal Fatigue Effects on Selected Components in a Boiling Water Reactor Plant," Electric Power Research Institute, April 1998.

4.3-6 EPRI Report No. TR-107943, "Environmental Fatigue Evaluations of Representative BWR Components," Electric Power Research Institute, May 1998.

4.3-7 NUREG/CR-6260 (INEL-95/0045), "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components," U. S. Nuclear Regulatory Commission, March 1995.

4.3-8 NUREG/CR-5999 (ANL-93/3), "Interim Fatigue Design Curves for Carbon, Low-Alloy, and Austenitic Stainless Steels in LWR Environments," U. S. Nuclear Regulatory Commission, August 1993.

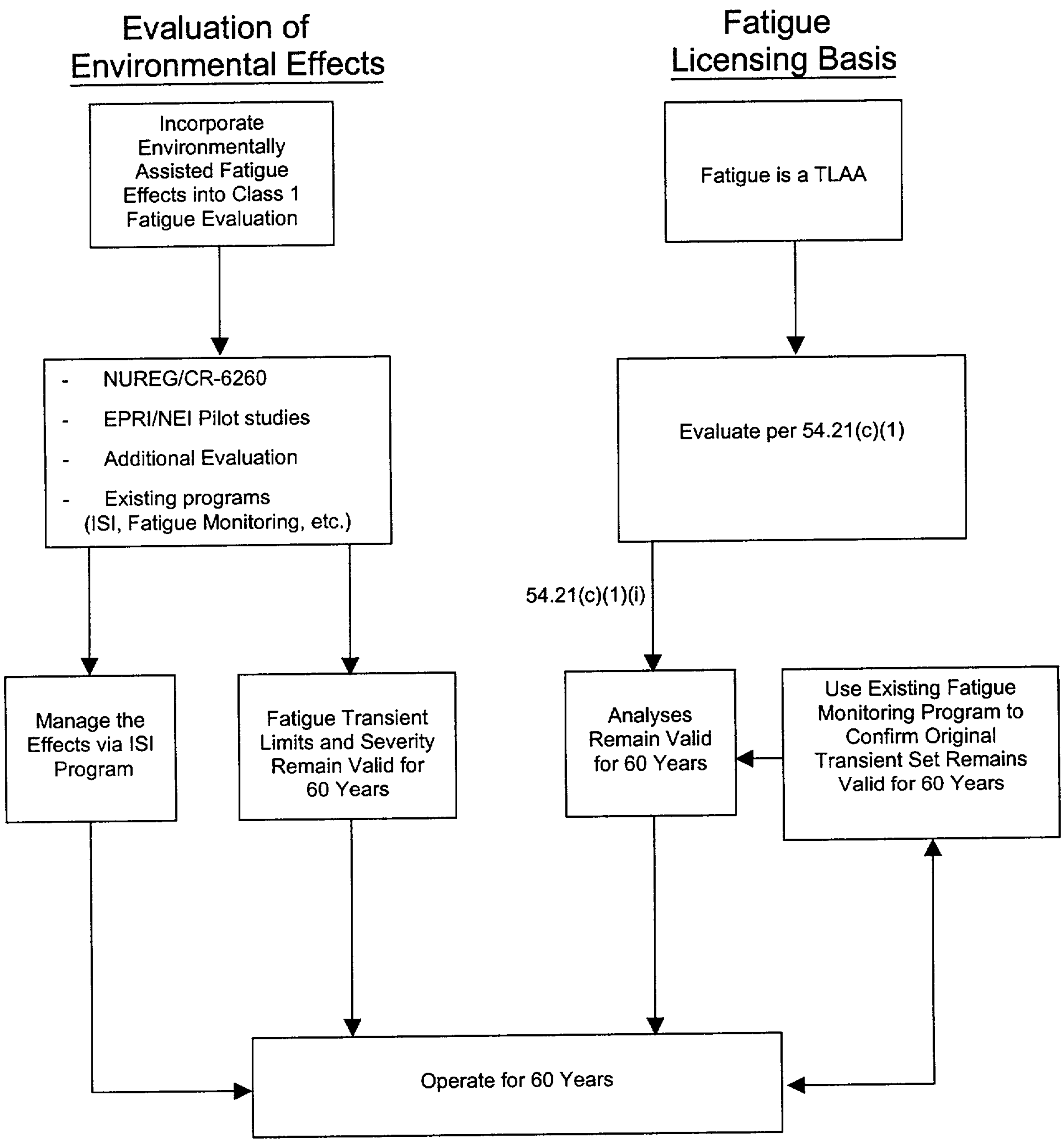
4.3-9 NUREG/CR-6583 (ANL-97/18), "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels," U. S. Nuclear Regulatory Commission, March 1998.

4.3-10 NUREG/CR-5704 (ANL-98/31), "Effects of LWR Coolant Environments on Fatigue Design Curves of Austenitic Stainless Steels," U. S. Nuclear Regulatory Commission, April 1999.

4.3-11 FPL Letter, L-2000-010 to U. S. Nuclear Regulatory Commission, Turkey Point Unit 3, Docket No. 50-250, "Risk Informed Inservice Inspection Program," January 19, 2000.

FIGURE 4.3-1

GSI-190 EVALUATION PROCESS



4.4 ENVIRONMENTAL QUALIFICATION

The thermal, radiation, and wear cycle aging analyses of plant electrical and I&C components required to meet 10 CFR 50.49 have been identified as time-limited aging analyses for Turkey Point Units 3 and 4.

The Nuclear Regulatory Commission has established nuclear station environmental qualification requirements in 10 CFR 50, Appendix A, and in 10 CFR 50.49. The requirements in 10 CFR 50.49 specify that an environmental qualification program be established to demonstrate that certain electrical and I&C components located in "harsh" plant environments (i.e., those areas of the plant that could be subject to the harsh environment effects of a loss-of-coolant accident, high energy line break, or post loss-of-coolant accident radiation) are qualified to perform their safety function in those harsh environments after the effects of in-service aging. Further, 10 CFR 50.49 requires that the effects of significant aging mechanisms be addressed as part of environmental qualification.

All operating plants must meet the requirements of 10 CFR 50.49 for certain electrical and I&C components important-to-safety. 10 CFR 50.49 defines the scope of components to be included, requires the preparation and maintenance of a list of in-scope components, and requires the preparation and maintenance of a qualification file that includes component performance specifications, electrical characteristics, and environmental conditions. The requirements in 10 CFR 50.49(e)(5) contain provisions for aging that require, in part, consideration of all significant types of aging degradation that can affect component functional capability. 10 CFR 50.49(e) also requires component replacement or refurbishment prior to the end of designated life unless additional life is established through ongoing qualification. 10 CFR 50.49(f) establishes four methods of demonstrating qualification for aging and accident conditions. The requirements in 10 CFR 50.49 (k) and (l) permit different criteria to apply based on plant and component vintage. Supplemental environmental qualification regulatory guidance for compliance with these different qualification criteria is provided in the DOR Guidelines, "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors" [Reference 4.4-1], NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment" [Reference 4.4-2], and Regulatory Guide 1.89, Revision 1, "Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants" [Reference 4.4-3]. Compliance with 10 CFR 50.49 provides evidence that the component will perform its intended functions during accident conditions after experiencing the effects of in-service aging.

The Turkey Point Environmental Qualification Program, which complies with all applicable regulations, includes three main elements: identifying applicable equipment and environmental requirements, establishing the qualification, and maintaining (or preserving) that qualification.

The first element involves establishment and control of the Environmental Qualification List of components and the service conditions for the harsh environment plant areas. The second element involves establishment and control of the components' environmental qualification documentation, including vendor test reports, vendor correspondence, calculations, evaluations of component tested conditions to plant required conditions, and determinations of configuration and maintenance requirements. The third element includes preventive maintenance processes (for replacing parts and components at specified intervals), design control processes (ensuring changes to the plant are evaluated for impact to the Environmental Qualification Program), procurement processes (ensuring new and replacement components are purchased to applicable environmental qualification requirements), and corrective action processes in accordance with the FPL Quality Assurance Program.

Components included in the Turkey Point Environmental Qualification Program have been evaluated to determine if existing environmental qualification aging analyses remain valid for the period of extended operation. Qualification for the license renewal period will be treated the same as for components currently qualified at Turkey Point for 40 years or less.

The Turkey Point Environmental Qualification Program manages component thermal, radiation, and wear cycle aging through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. As required by 10 CFR 50.49, environmentally qualified components must be refurbished, replaced, or their qualification extended prior to reaching the aging limits established in the evaluation. Aging evaluations for environmentally qualified components that specify a qualification of at least 40 years are considered time-limited aging analyses for license renewal.

4.4.1 ELECTRICAL AND I&C COMPONENT ENVIRONMENTAL QUALIFICATION ANALYSES

Age-related service conditions that are applicable to environmentally qualified components (i.e., 60 years of exposure versus 40 years) were evaluated for the period of extended operation to verify that the current environmental qualification analyses were bounding. Temperature and radiation values assumed for service conditions in the environmental qualification analyses are the maximum design operating values for Turkey Point. The following paragraphs describe the thermal, radiation, and wear cycle aging effects that were evaluated.

THERMAL CONSIDERATIONS - The component qualification temperatures were calculated for 60 years using the Arrhenius method, as described in EPRI NP-1558, "A Review of Equipment Aging Theory and Technology" [Reference 4.4-4]. The Turkey Point Environmental Qualification Program temperature for inside Containment is 50°C and for areas outside Containment is up to 40°C. For conservatism, a temperature rise of 10°C was added to the maximum design operating temperature for continuous duty power cables to account for ohmic heating. This results in maximum design operating temperatures of 60°C inside Containment and 50°C outside Containment for these power cables and penetrations. If the component qualification temperature bounded the maximum design operating temperatures, then no additional evaluation was required.

In connection with plant modifications, in 1991, some new environmentally qualified components that will not experience 60 years of thermal aging by the end of the license renewal period were installed at Turkey Point. In these cases, credit may be taken for less than 60 years of aging. This applies to two environmental qualification analyses, Patel/EGS conformal splices and Patel/EGS Grayboot connectors, described in Subsections 4.4.1.38 and 4.4.1.39, respectively.

RADIATION CONSIDERATIONS - The Turkey Point Environmental Qualification Program has established bounding radiation dose qualification values for all environmentally qualified components. These bounding radiation dose values were determined by component vendors through testing. To verify that the bounding radiation values are acceptable for the period of extended operation, 60-year integrated dose values were determined and then compared to the bounding values. The total integrated dose for the 60-year period is determined by adding the established accident dose to the 60-year normal operating dose for the component.

WEAR CYCLE CONSIDERATIONS - The wear cycle aging effect is only applicable to ASCO solenoid valves for Turkey Point (see Subsection 4.4.1.3). ASCO has established a wear cycle limit of 40,000 cycles for these valves. The projected cycles for 60 years for these valves were determined, and then compared to the limit provided by the vendor to establish acceptability for the period of extended operation.

The values for margin identified in Section 6.3.1.5 of IEEE 323-1974 were used as criteria in the Turkey Point Environmental Qualification Program. The only regular exception to the IEEE 323-1974 margins was for radiation. As identified in Item 1.4 of NUREG-0588, additional margin need not be added to the radiation parameters if the methods identified in Appendix D of NUREG-0588 are utilized. The methods used to determine the Turkey Point radiation parameters are consistent with the Appendix D methodology. Hence, the radiation margins required by Section 6.3.1.5 of IEEE 323-1974 are not necessary. Accordingly, margin is adequately addressed in the Turkey Point Environmental Qualification Program.

The following Subsections (4.4.1.1 through 4.4.1.39) provide a description for each of the environmental qualification analyses for the period of extended operation.

4.4.1.1 ANACONDA CABLES

Anaconda cables are installed in instrumentation, control, and power applications, both inside and outside the Containments at Turkey Point. Cable insulation for environmentally qualified Anaconda cables is either FR-EP or EP.

THERMAL ANALYSIS

The qualified life analysis for Anaconda instrumentation and control cables shows the cables are qualified for continuous operation for 60 years at a temperature of 67.9°C. Instrumentation and control cables are subject to minimal temperature rise with a resulting maximum design operating temperature of 50°C.

The qualified life analysis for Anaconda power cables shows the cables are qualified for continuous operation for 60 years at a temperature of 72.0°C. The power cables have a maximum design operating temperature of 60°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Anaconda power and instrumentation/control cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $5x10^7$ rads.

CONCLUSION

Anaconda instrumentation, control, and power cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.2 AIW CABLES

AIW cables are installed in outside Containment instrumentation circuits at Turkey Point. This includes all outdoor areas. Cable insulation for environmentally qualified AIW cables is PE.

THERMAL ANALYSIS

The qualified life analysis for AIW cables shows the cables are qualified for continuous operation for 60 years at a temperature of 53.8°C. AIW instrumentation cables are subject to minimal temperature rise with a resulting maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for AIW cables shows the cables are qualified for 7.5×10^7 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 7.56×10^6 rads.

CONCLUSION

AIW instrumentation cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.3 ASCO SOLENOID VALVES

Normally de-energized ASCO solenoid valves are installed both inside and outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for normally de-energized ASCO solenoid valves shows the solenoid valves are qualified for greater than 60 years at ambient temperatures of 50°C inside Containment and 40°C outside Containment. Normally de-energized ASCO solenoid valves have maximum design operating temperatures of 50°C inside Containment and 40°C outside Containment.

RADIATION ANALYSIS

The qualified life analysis for normally de-energized ASCO solenoid valves shows the solenoid valves are qualified for 2×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 4×10^7 rads.

WEAR/CYCLES ANALYSIS

The qualified life analysis for normally de-energized ASCO solenoid valves shows the solenoid valves are qualified for 40,000 cycles. The maximum projected usage is less than 1000 cycles.

CONCLUSION

Normally de-energized ASCO solenoid valves are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.4 BRAND REX COAXIAL CABLES

Brand Rex coaxial cables are installed for instrumentation applications inside the Containments at Turkey Point. Cable insulation for environmentally qualified Brand Rex coaxial cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for Brand Rex coaxial cables shows the cables are qualified for continuous operation for 60 years at a temperature of 53.8°C. The cables have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Brand Rex coaxial cables shows the cables are qualified for $1.8x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Brand Rex coaxial cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.5 BRAND REX INSTRUMENT CABLES

Brand Rex 600 volt instrumentation cables are installed both inside and outside the Containments at Turkey Point. Cable insulation for environmentally qualified Brand Rex 600 volt instrumentation cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for Brand Rex instrument cables shows the cables are qualified for continuous operation for greater than 60 years at a temperature of 50.0°C. Instrumentation and control cables are subject to minimal temperature rise with a resulting maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Brand Rex instrument cables shows the cables are qualified for $1.8x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Brand Rex instrument cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.6 CONAX CONDUIT SEALS

Conax conduit seal assemblies are installed inside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Conax conduit seal assemblies shows the seal assemblies are qualified for continuous operation for greater than 60 years at a temperature of 50°C. The seal assemblies have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Conax conduit seal assemblies shows the seal assemblies are qualified for 2.25×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 4×10^7 rads.

CONCLUSION

Conax conduit seal assemblies are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.7 CONAX PENETRATIONS

Conax electrical penetrations are installed inside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Conax power penetrations shows the penetrations are qualified for continuous operation for 60 years at a temperature of 93.7°C. The qualified life analysis for Conax instrumentation and control penetrations shows the penetrations are qualified for continuous operation for greater than 60 years at a temperature of 50°C. The Conax power penetrations have a maximum design operating temperature of 60°C (includes 10°C of ohmic heating). The Conax instrumentation and control penetrations have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Conax electrical penetrations shows the electrical penetrations are qualified for $1.2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Conax electrical penetrations are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.8 CONAX UNITIZED RESISTANCE TEMPERATURE DETECTORS

Conax Unitized resistance temperature detectors are installed inside the Containments at Turkey Point for the containment atmosphere temperature instrument loops.

THERMAL ANALYSIS

The qualified life analysis for Conax Unitized resistance temperature detectors shows the RTDs are qualified for continuous operation for greater than 60 years at a temperature of 50°C. The resistance temperature detectors have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Conax Unitized resistance temperature detectors shows the resistance temperature detectors are qualified for $2.2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Conax Unitized resistance temperature detectors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.9 CHAMPLAIN CABLES

Champlain cables are installed outside the Containments at Turkey Point. Cable insulation for environmentally qualified Champlain cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for Champlain cables shows the cables are qualified for continuous operation for 60 years at a temperature of 85°C. The cables have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for Champlain cables shows the cables are qualified for 2×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 7.56×10^6 rads.

CONCLUSION

Champlain cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.10 CROUSE HINDS PENETRATIONS

Crouse Hinds penetrations are installed inside the Containments for containment electrical penetrations at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Crouse Hinds penetrations shows the penetrations are qualified for continuous operation for 60 years at temperatures of 50°C for instrumentation and control penetrations and 60°C for power penetrations. The penetrations have maximum design operating temperatures of 50°C for instrumentation and control penetrations and 60°C (includes 10°C of ohmic heating) for power penetrations.

RADIATION ANALYSIS

The qualified life analysis for Crouse Hinds penetrations shows the penetrations are qualified for 1×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 4×10^7 rads.

CONCLUSION

Crouse Hinds penetrations are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.11 GENERAL ATOMIC RADIATION MONITORS

General Atomic radiation monitors are installed inside the Containments at Turkey Point.

THERMAL ANALYSIS

The General Atomic radiation monitor detectors are composed entirely of inorganic materials and not susceptible to thermal degradation.

RADIATION ANALYSIS

The General Atomic radiation monitor detectors are composed of inorganic components. The only component susceptible to radiation aging is the ionization chamber. The ionization chambers are qualified for $1x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for the ionization chambers is $4x10^7$ rads.

CONCLUSION

General Atomic radiation monitors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.12 GENERAL CABLES

General cables are installed for 5kV power cables outside the Containments at Turkey Point. Cable insulation for environmentally qualified General cables is butyl rubber.

THERMAL ANALYSIS

The qualified life analysis for General cables shows the cables are qualified for continuous operation for 60 years at a temperature of 66.6°C. The cables have a maximum design operating temperature of 50°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for General cables shows the cables are qualified for $3x10^6$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $2.46x10^6$ rads.

CONCLUSION

General cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.13 GENERAL ELECTRIC CABLES

General Electric cables are installed as instrumentation cables and jumper wires both inside and outside the Containments at Turkey Point. Cable insulation for environmentally qualified General Electric cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for General Electric instrumentation cables shows the cables are qualified for continuous operation for 60 years at a temperature of 70°C. The cables have a maximum design operating temperature of 50°C.

The qualified life analysis for General Electric jumper wires shows the jumper wires are qualified for 40 years at a temperature of 64.7°C, plus 20 years at a temperature of 75°C (due to space heaters that were energized during the first twenty years of plant operation). The jumper wires have a maximum design operating temperature of 60°C (includes 10°C for ohmic heating). An additional 15°C is also added for the first 20 years of operation to account for space heaters being energized.

RADIATION ANALYSIS

The qualified life analysis for General Electric instrumentation cables and jumper wires shows they are qualified for $5x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $5x10^7$ rads.

CONCLUSION

General Electric cables, installed as instrumentation cables and jumper wires, are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.14 GENERAL ELECTRIC TERMINAL BLOCKS

General Electric terminal blocks are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for General Electric terminal blocks shows the terminal blocks are qualified for continuous operation for greater than 60 years at a temperature of 40°C. The terminal blocks have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for General Electric terminal blocks shows the terminal blocks are qualified for $2x10^8$ rads (EB-5) and $1.2x10^7$rads (EB-25). The maximum projected post accident plus 60-year normal operation radiation dose is $7.5x10^6$ rads.

CONCLUSION

General Electric terminal blocks are qualified for the period of extended operation based on the determination that the analyses remain remains valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.15 JOY EMERGENCY CONTAINMENT COOLER AND EMERGENCY CONTAINMENT FILTRATION FAN MOTORS

Joy emergency containment cooler and emergency containment filtration fan motors are installed inside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Joy emergency containment cooler and emergency containment filtration fan motors shows the motors are qualified for 0.25 years of operation at 115°C and 59.75 years of standby operation at 101.6°C. The Joy emergency containment cooler and emergency containment filtration fan motors have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Joy emergency containment cooler and emergency containment filtration fan motors shows the motors are qualified for $3x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Joy emergency containment cooler and emergency containment filtration fan motors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.16 LIMITORQUE VALVE OPERATORS WITH RELIANCE MOTORS FOR USE INSIDE CONTAINMENT

Limitorque valve operators with Reliance motors are installed inside the Containments for various motor-operated valves at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors shows the actuators are qualified for greater than 60 years at an ambient temperature of 55°C. A temperature of 5°C was added to the maximum design operating temperature of 50°C inside Containment to account for the space heaters being energized during the first 20 years of plant life. The space heaters were disconnected at that point. The actuators have a maximum design operating temperature of 55°C (includes an adjustment of 5°C as described above).

RADIATION ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors shows the actuators are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Limitorque valve operators with Reliance motors for use inside Containment are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.17 LIMITORQUE VALVE OPERATORS WITH RELIANCE MOTORS WITH CLASS H(RH) INSULATION FOR USE INSIDE CONTAINMENT

Limitorque valve operators with Reliance motors with Class H(RH) insulation are installed inside the Containments for various motor-operated valves at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors with Class H(RH) insulation shows the actuators are qualified for greater than 60 years at an ambient temperature of 55°C. A temperature of 5°C was added to the maximum design operating temperature of 50°C inside containment to account for the space heaters being energized during the first 20 years of plant life. The space heaters were disconnected at that point. The actuators have a maximum design operating temperature of 55°C (includes an adjustment of 5°C as described above).

RADIATION ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors with Class H(RH) insulation shows the actuators are qualified for 2×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 4×10^7 rads.

CONCLUSION

Limitorque valve operators with Reliance motors with Class H(RH) insulation for use inside Containment are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.18 LIMITORQUE VALVE OPERATORS WITH RELIANCE MOTORS FOR USE OUTSIDE CONTAINMENT

Limitorque valve operators with Reliance motors are installed outside the Containments for various motor-operated valves at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors shows the actuators are qualified for greater than 60 years at an ambient temperature of 40°C. The actuators have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for Limitorque valve operators with Reliance motors shows the actuators are qualified for $2x10^7$ rads. The maximum projected post accident plus 60 year normal operation radiation dose is $2.0x10^6$ rads.

CONCLUSION

Limitorque valve operators with Reliance motors for use outside Containment are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.19 LIMITORQUE VALVE OPERATORS WITH PEERLESS MOTORS FOR USE OUTSIDE CONTAINMENT

Limitorque valve operators with Peerless motors are installed outside the Containments for various motor-operated valves at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Limitorque valve operators with Peerless motors shows the actuators are qualified for greater than 60 years at an ambient temperature of 40°C. The actuators have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for Limitorque valve operators with Peerless motors shows the actuators are qualified for $1x10^7$ rads. These actuators are located in a mild radiation environment at Turkey Point, resulting in a maximum projected post accident plus 60 year normal operation radiation dose of $1x10^5$ rads.

CONCLUSION

Limitorque valve operators with Peerless motors for use outside Containment are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.20 OKONITE CABLES

Okonite X-Olene/Okoseal 600V power and control cables are installed inside and outside the Containments at Turkey Point. Okonite Okonex/Okoseal 600V power cables are installed outside the Containments at Turkey Point. Okonite Okolene/Okoseal 600V instrumentation and control cables are installed outside the Containments at Turkey Point. Cable insulation for environmentally qualified Okonite X-Olene/Okoseal 600V power and control cables is XLPE. Cable insulation for environmentally qualified Okonite Okonex/Okoseal 600V power cables is butyl rubber. Cable insulation for environmentally qualified Okonite Okolene/Okoseal 600V instrumentation and control cables is PE.

THERMAL ANALYSIS

The qualified life analysis for Okonite X-Olene/Okoseal 600V power and control cables, Okonite Okonex/Okoseal 600V power cables, and Okonite Okolene/Okoseal 600V instrumentation and control cables shows the cables are qualified for continuous operation for greater than 60 years at temperatures of 60°C (power) and 50°C (I&C) for inside Containment cables and 50°C (power) and 40°C (I&C) for outside Containment cables. The cables have maximum design operating temperatures of 60°C (includes 10°C of ohmic heating) for inside Containment cables and 50°C (includes 10°C of ohmic heating) for outside Containment cables.

RADIATION ANALYSIS

The qualified life analysis for Okonite X-Olene/Okoseal 600V power and control cable shows the cable is qualified for $1x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for Okonite X-Olene/Okoseal 600V power and control cable at Turkey Point is $4x10^7$ rads.

The qualified life analysis for Okonite Okonex/Okoseal 600V power cable shows the cable is qualified for $5x10^6$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for Okonite Okonex/Okoseal 600V power cable is $2.22x10^6$ rads.

The qualified life analysis for Okonite Okolene/Okoseal 600V instrumentation and control cable shows the cable is qualified for $1x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for Okonite Okolene/Okoseal 600V instrumentation and control cable is $7.6x10^6$ rads.

CONCLUSION

Okonite cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.21 RAYCHEM HEAT SHRINK SLEEVING

Raychem heat shrink sleeving is installed both inside and outside the Containments for insulation of electrical connections at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for WCSF-N, WCSF-050-N, NMCK, and RNF-100 sleeving materials shows the sleeving is qualified for continuous operation for greater than 60 years at a temperature of 85°C. The WCSF-N and WCSF-050-N sleeving materials have a maximum design operating temperature of 53.2°C, NMCK and RNF-100 sleeving materials have a maximum design operating temperature of 50°C.

The qualified life analysis for NHVT sleeving material shows the sleeving is qualified for 7.5 years of operation at a temperature of 50°C, and at least 148 additional years at 40°C. This exceeds the required 7.5 years at 50°C and 52.5 years at 40°C for residual heat removal pump motor operation.

The qualified life analysis for NMCK-8(L) sleeving material shows the sleeving is qualified for continuous operation for 60 years at a temperature of 78°C. The NMCK-8(L) sleeving material has a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for WCSF-N sleeving material shows the sleeving is qualified for $2x10^8$ to $2.9x10^8$ rads for bolted and butt connections. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

The qualified life analysis for NMCK sleeving material shows the sleeving is qualified for $2.9x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

The qualified life analysis for RNF-100, WCSF-050-N, and NHVT sleeving material shows the sleeving is qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for RNF-100 is $7.56x10^6$ rads, for WCSF-050-N is $4x10^7$ rads, and for NHVT is $2.4x10^6$ rads.

The qualified life analysis for NMCK-8(L) sleeving material shows the sleeving is qualified for $5x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $2.4x10^6$ rads.

CONCLUSION

Raychem heat shrink sleeving is qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.22 RAYCHEM CABLES

Raychem cables are installed inside the Containments at Turkey Point in 600V control circuits. Cable insulation for environmentally qualified Raychem cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for Raychem cables shows the cables are qualified for continuous operation for greater than 60 years at a temperature of 60°C. The cables have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Raychem cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Raychem cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.23 MACWORTH REES PUSHBUTTON STATIONS

MacWorth Rees pushbutton stations are installed outside the Containments for control of various motors at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for MacWorth Rees pushbutton stations shows the pushbutton stations are qualified for continuous operation for greater than 60 years at a temperature of 40°C. The pushbutton stations have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for MacWorth Rees pushbutton stations shows the pushbutton stations are qualified for $1x10^6$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $7.51x10^5$ rads.

CONCLUSION

MacWorth Rees pushbutton stations are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.24 ROCKBESTOS CABLES

Rockbestos cables are installed as control, instrumentation, and power cables both inside and outside the Containments at Turkey Point. Cable insulation for environmentally qualified Rockbestos cables is XLPE.

THERMAL ANALYSIS

The qualified life analysis for Rockbestos instrumentation and control cables shows the cables are qualified for continuous operation for 60 years at a temperature of 54°C. The instrumentation and control cables have a maximum design operating temperature of 50°C.

The qualified life analysis for Rockbestos power cables shows the cables are qualified for continuous operation for 60 years at a temperature of 87°C. The cables have a maximum design operating temperature of 60°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Rockbestos control, instrumentation, and power cables shows the cable and wire are qualified for 1.84×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 5×10^7 rads.

CONCLUSION

Rockbestos control, instrumentation, and power cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.25 SAMUEL MOORE CABLES

Samuel Moore cables are installed as 600V instrumentation cables inside the Containments at Turkey Point. Cable insulation for environmentally qualified Samuel Moore cables is EPDM.

THERMAL ANALYSIS

The qualified life analysis for Samuel Moore instrumentation cables shows the cables are qualified for continuous operation for 60 years at a temperature of 49.7°C. Although this temperature is below the inside Containment environmental qualification temperature of 50°C, the temperature of 49.7°C is above the Technical Specification Containment temperature limit of 48.9°C. The integrated maximum temperature profile for inside Containment over Turkey Point's history has been and will be below the Technical Specification limit.

RADIATION ANALYSIS

The qualified life analysis for Samuel Moore cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

The analyses associated with the environmental qualification of Samuel Moore cables have been projected to the end of the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

4.4.1.26 3M INSULATING TAPE AND SCOTCHFIL

3M Insulating tape and Scotchfil are installed outside the Containments for splicing and terminations at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for 3M Insulating tapes and Scotchfil shows the insulating materials are qualified for continuous operation for greater than 60 years at a temperature of 50°C. The 3M Insulating tape and Scotchfil have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for 3M Insulating tapes shows the tapes are qualified for $2x10^8$ rads (Type 130C/33+), $1x10^8$ rads (Types 23, 130C, and 70), and $5x10^7$ rads (Type 33+). The qualified life analysis for 3M Scotchfil shows that Scotchfil is qualified for $6.02x10^6$ rads. The maximum projected post accident plus 60-year normal operation radiation dose for both 3M Insulating tape and Scotchfil is $2.4x10^6$ rads.

CONCLUSION

3M Insulating tape and Scotchfil are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.27 WESTINGHOUSE RESIDUAL HEAT REMOVAL PUMP MOTORS

Westinghouse residual heat removal pump motors are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Westinghouse residual heat removal pump motors shows the motors are qualified for 7.2 years of operation at 120°C and 53.3 years of standby operation at 94.6°C. The Westinghouse residual heat removal pump motors have maximum design temperatures of 120°C when operating and 93°C when in standby.

RADIATION ANALYSIS

The qualified life analysis for the Westinghouse residual heat removal pump motors shows the motors are qualified for $5x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $2.2x10^5$ rads.

CONCLUSION

Westinghouse residual heat removal pump motors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.28 WESTINGHOUSE CONTAINMENT SPRAY PUMP MOTORS

Westinghouse containment spray pump motors are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Westinghouse containment spray pump motors shows the motors are qualified for 0.3 years of operation at 130°C and 59.7 years of standby operation at 97.1°C. The Westinghouse containment spray pump motors have maximum design temperatures of 130°C when operating and 93°C when in standby.

RADIATION ANALYSIS

The qualified life analysis for the Westinghouse containment spray pump motors shows the motors are qualified for 5×10^7 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 8.1×10^5 rads.

CONCLUSION

Westinghouse containment spray pump motors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.29 WESTINGHOUSE SAFETY INJECTION PUMP MOTORS

Westinghouse safety injection pump motors are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Westinghouse safety injection pump motors shows the motors are qualified for 0.3 years of operation at 130°C and 59.7 years of standby operation at 97.1°C. The Westinghouse safety injection pump motors have maximum design temperatures of 130°C when operating and 93°C when in standby.

RADIATION ANALYSIS

The qualified life analysis for the Westinghouse safety injection pump motors shows the motors are qualified for $5x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $8.1x10^5$ rads.

CONCLUSION

Westinghouse safety injection pump motors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.30 COMBUSTION ENGINEERING MINERAL INSULATED CABLES AND CONNECTORS

Combustion Engineering Mineral Insulated cables with ERD twin-pin and multi-pin connectors, Litton connectors with Grafoil seals, G&H connectors, and Litton "B" connectors are installed inside the Containments at Turkey Point for the core exit thermocouples and heated junction thermocouples.

THERMAL ANALYSIS

The qualified life analysis for Combustion Engineering Mineral Insulated cables with ERD twin-pin and multi-pin connectors, Litton connectors with Grafoil seals, G&H connectors, and Litton "B" connectors shows the cables are qualified for continuous operation for greater than 60 years at a temperature of 55°C. The cables have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Combustion Engineering Mineral Insulated cables with ERD twin-pin and multi-pin connectors, Litton connectors with Grafoil seals, and G&H connectors shows the cables are qualified for $2.2x10^8$ rads. The qualified life analysis for Combustion Engineering Mineral Insulated cables with Litton "B" connectors shows the cables are qualified for $2.1x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Combustion Engineering Mineral Insulated cables with ERD twin-pin and multi-pin connectors, Litton connectors with Grafoil seals, G&H connectors, and Litton "B" connectors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.31 KERITE HTK/FR CABLES

Kerite HTK/FR cables are installed in 600V power applications inside the Containments at Turkey Point. Insulation and jackets for environmentally qualified Kerite HTK/FR cables are HTK and FR, respectively.

THERMAL ANALYSIS

The qualified life analysis for Kerite HTK/FR cables shows the cables are qualified for continuous operation for 60 years at a temperature of 80.1°C. The cables have a maximum design operating temperature of 60°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Kerite HTK/FR cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $5x10^7$ rads.

CONCLUSION

Kerite HTK/FR cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.32 KERITE FR2/FR CABLES

Kerite FR2/FR cables are installed both inside and outside the Containments at Turkey Point in 600V instrumentation, control, and power applications. Insulation and jackets for environmentally qualified Kerite FR2/FR cables are FR2 and FR, respectively.

THERMAL ANALYSIS

The qualified life analysis for Kerite FR2/FR cables shows the cables are qualified for continuous operation for 60 years at a temperature of 80°C. The cables have a maximum design operating temperature of 60°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Kerite FR2/FR cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $5x10^7$ rads.

CONCLUSION

Kerite FR2/FR cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.33 KERITE FR/FR CABLES

Kerite FR/FR cables are installed both inside and outside the Containments at Turkey Point in 600V control applications. Insulation and jackets for environmentally qualified Kerite FR/FR cables are FR.

THERMAL ANALYSIS

The qualified life analysis for Kerite FR/FR cables shows the cables are qualified for continuous operation for 60 years at a temperature of 80°C. The cables have a maximum design operating temperature of 50°C.

RADIATION ANALYSIS

The qualified life analysis for Kerite FR/FR cables shows the cables are qualified for $5x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $5x10^7$ rads.

CONCLUSION

Kerite FR/FR cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.34 KERITE HTK/FR POWER CABLES

Kerite HTK/FR power cables are installed outside the Containments at Turkey Point in 8000V power applications. Insulation and jackets for environmentally qualified Kerite HTK/FR power cables are HTK and FR, respectively.

THERMAL ANALYSIS

The qualified life analysis for Kerite HTK/FR power cables shows the cables are qualified for continuous operation for 60 years at a temperature of 80°C. The cables have a maximum design operating temperature of 50°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Kerite HTK/FR power cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $2.9x10^5$ rads.

CONCLUSION

Kerite HTK/FR power cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.35 TELEDYNE THERMATICS CABLES

Teledyne Thermatics cables are installed both inside and outside the Containments at Turkey Point. Insulation for environmentally qualified Teledyne Thermatics cables is Tefzel 280.

THERMAL ANALYSIS

The qualified life analysis for Teledyne Thermatics cables shows the cables are qualified for continuous operation for 60 years at a temperature of 65.0°C. The cables have a maximum design operating temperature of 61.2°C (includes 11.2°C for the space heaters inside the Limitorque operators being energized during the first 20 years of operation).

RADIATION ANALYSIS

The qualified life analysis for the Teledyne Thermatics cables shows the cables are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

Teledyne Thermatics cables are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.36 WEED RESISTANCE TEMPERATURE DETECTORS

Weed resistance temperature detectors are installed both inside and outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Weed resistance temperature detectors shows the resistance temperature detectors are qualified for continuous operation for greater than 60 years at a temperature of 52.7°C. The resistance temperature detectors have a maximum design operating temperature of 51.6°C (includes 1.6°C for effects of the high process temperature being measured).

RADIATION ANALYSIS

The qualified life analysis for Weed resistance temperature detectors shows the resistance temperature detectors are qualified for $3x10^8$ rads. The maximum projected post accident plus 60 year normal operation radiation dose is $1.06x10^8$ rads inside Containment, and $7.5x10^6$ rads outside Containment.

CONCLUSION

Weed resistance temperature detectors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.37 AMERACE NQB TERMINAL BLOCKS

Amerace NQB terminal blocks are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The qualified life analysis for Amerace NQB terminal blocks shows the terminal blocks are qualified for continuous operation for 60 years at a temperature of 44°C. The terminal blocks have a maximum design operating temperature of 40°C.

RADIATION ANALYSIS

The qualified life analysis for Amerace NQB terminal blocks shows the terminal blocks are qualified for 2×10^8 rads. The maximum projected post accident plus 60-year normal operation radiation dose is 7.56×10^6 rads.

CONCLUSION

Amerace NQB terminal blocks are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.38 PATEL/EGS CONFORMAL SPLICES

Patel/EGS conformal splices are installed outside the Containments at Turkey Point.

THERMAL ANALYSIS

The Patel/EGS conformal splices were first installed at Turkey Point in 1991. The qualified life analysis for Patel/EGS conformal splices shows the conformal splices are qualified for continuous operation for 42 years (1991-2033) at a temperature of 90°C. The conformal splices have a maximum design operating temperature of 50°C (includes 10°C of ohmic heating).

RADIATION ANALYSIS

The qualified life analysis for Patel/EGS conformal splices shows the conformal splices are qualified for $2x10^7$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $7.5x10^6$ rads.

CONCLUSION

The Patel/EGS conformal splices are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.1.39 PATEL/EGS GRAYBOOT CONNECTORS

Patel/EGS Grayboot connectors are installed both inside and outside the Containments at Turkey Point.

THERMAL ANALYSIS

The Patel/EGS Grayboot connectors were first installed at Turkey Point in 1991. The qualified life analysis for Patel/EGS Grayboot connectors shows the connectors are qualified for continuous operation for 42 years (1991-2033) at a temperature of 55.7°C. The connectors have a maximum design operating temperature of 55.6°C (includes 5.6°C of ohmic heating based on the specific Grayboot connector applications).

RADIATION ANALYSIS

The qualified life analysis for Patel/EGS Grayboot connectors shows the connectors are qualified for $2x10^8$ rads. The maximum projected post accident plus 60-year normal operation radiation dose is $4x10^7$ rads.

CONCLUSION

The Patel/EGS Grayboot connectors are qualified for the period of extended operation based on the determination that the existing analyses remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.4.2 GSI-168, ENVIRONMENTAL QUALIFICATION OF ELECTRICAL COMPONENTS

NRC guidance for addressing GSI-168 for license renewal is contained in the June 2, 1998, NRC letter to NEI [Reference 4.4-5]. In this letter, the NRC states, "With respect to addressing GSI-168 for license renewal, until completion of an ongoing research program and staff evaluations, the potential issues associated with GSI-168 and their scope have not been defined to the point that a license renewal applicant can reasonably be expected to address them at this time. Therefore, an acceptable approach described in the Statements of Consideration is to provide a technical rationale demonstrating that the current licensing basis for environmental qualification pursuant to 10 CFR 50.49 will be maintained in the period of extended operation. Although the Statements of Consideration also indicates that an applicant should provide a brief description of one or more reasonable options that would be available to adequately manage the effects of aging, the staff does not expect an applicant to provide the options at this time."

Environmental qualification evaluations of electrical equipment are identified as time-limited aging analyses for Turkey Point Units 3 and 4. The evaluations of these time-limited aging analyses are considered the technical rationale that the current licensing basis will be maintained during the period of extended operation. These evaluations are provided in Section 4.4 of the Turkey Point License Renewal Application. Consistent with the above NRC guidance, no additional information is required to address GSI-168 in a renewal application at this time.

4.4.3 REFERENCES

4.4-1 DOR Guidelines, "Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors," U. S. Nuclear Regulatory Commission, June 1979.

4.4-2 NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment," U. S. Nuclear Regulatory Commission, July 1981.

4.4-3 Regulatory Guide 1.89, Revision 1, "Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants," U. S. Nuclear Regulatory Commission, June 1984.

4.4-4 EPRI NP-1558, "A Review of Equipment Aging Theory and Technology," Electric Power Research Institute, September 1980.

4.4-5 C. I. Grimes (NRC) letter to D. Walters (NEI), "Guidance on Addressing GSI 168 for License Renewal," Project 690, June 2, 1998.

4.5 CONTAINMENT TENDON LOSS OF PRESTRESS

The Turkey Point Units 3 and 4 containment buildings are post-tensioned, reinforced concrete structures composed of vertical cylinder walls and a shallow dome, supported on a conventional reinforced concrete base slab. The cylinder walls are provided with vertical tendons and horizontal hoop tendons. The dome is provided with three groups of tendons oriented 120-degrees apart.

The prestress of containment tendons decreases over time as a result of seating of anchorage losses, elastic shortening of concrete, creep of concrete, shrinkage of concrete, relaxation of prestressing steel, and friction losses. At the time of initial licensing, the magnitude of the prestress losses throughout the life of the plant was predicted and the estimated final effective preload at the end of 40 years was calculated for each tendon type. The final effective preload was then compared with the minimum required preload to confirm the adequacy of the design.

New upper limit curves, lower limit curves, and trend lines of measured prestressing forces have been established for all tendons through the period of extended operation. The predicted final effective preload at the end of 60 years exceeds the minimum required preload for all containment tendons. Consequently, the post-tensioning system will continue to perform its intended function throughout the period of extended operation.

The analyses associated with containment tendon loss of prestress have been projected to the end of the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(ii).

As a confirmatory program, the Containment structure post-tensioning system surveillance performed as a part of the ASME Section XI, Subsection IWL Inservice Inspection Program will continue to be performed in accordance with the requirements of Technical Specifications 4.6.1.6.1 and 4.6.1.6.2. The ASME Section XI, Subsection IWL Inservice Inspection Program is described in Appendix B.

4.6 CONTAINMENT LINER PLATE FATIGUE

The interior surface of each Containment is lined with welded steel plate to provide an essentially leak-tight barrier. Design criteria are applied to the liner to assure that the specified allowed leak rate is not exceeded under the design basis accident conditions. The following fatigue loads, as described in UFSAR Appendix 5B, Section B.2.1, were considered in the design of the liner plates and are considered a time-limited aging analyses for the purposes of license renewal:

1. Thermal cycling due to annual outdoor temperature variations. The number of cycles for this loading is 40 for the plant life of 40 years.
2. Thermal cycling due to Containment interior temperature varying during the heatup and cooldown of the Reactor Coolant System. The number of cycles for this loading is assumed to be 500.
3. Thermal cycling due to the maximum hypothetical accident will be assumed to be one.
4. Thermal load cycles in the piping system are somewhat isolated from the liner plate penetrations by concentric sleeves between the pipe and the liner plate. The attachment sleeve is designed in accordance with ASME Boiler and Pressure Vessel Code, Section III, fatigue considerations. All penetrations are reviewed for a conservative number of cycles to be expected during the unit life.

Each of the above items has been evaluated for the period of extended operation.

For item (1.), the number of thermal cycles due to annual outdoor temperature variations was increased from 40 to 60 for the extended period of operation. The effect of this increase is insignificant in comparison to the assumed 500 thermal cycles due to Containment interior temperature varying during heatup and cooldown of the Reactor Coolant System. The 500 thermal cycles includes a margin of 300 thermal cycles above the 200 Reactor Coolant System allowable design heatup and cooldown cycles, which is sufficient margin to accommodate the additional 20 cycles of annual outdoor temperature variation. Therefore, this loading condition is considered valid for the period of extended operation as it is enveloped by item (2.).

For item (2.), the assumed 500 thermal cycles was evaluated based on the more limiting heatup and cooldown design cycles (transients) for the Reactor Coolant System. The Reactor Coolant System was designed to withstand 200 heatup and cooldown thermal cycles. The evaluation described in Subsection 4.3.1 determined that the originally projected number of maximum Reactor Coolant System design cycles is conservative enough to envelop the projected cycles for the extended period of operation. Therefore, the original containment liner plate fatigue analysis for 500 heatup and cooldown cycles is considered valid for the period of extended operation.

For item (3.), the assumed value for thermal cycling due to the maximum hypothetical accident remains valid. No maximum hypothetical accident has occurred and none is expected, therefore, this assumption is considered valid for the period of extended operation.

For item (4.), the design of the containment penetrations has been reviewed. The design meets the general requirements of the 1965 Edition of ASME Boiler and Pressure Vessel Code, Section III. The main steam piping, feedwater piping, blowdown piping, and letdown piping are the only piping penetrating the containment wall and liner plate that contribute significant thermal loading on the liner plate. The projected number of actual operating cycles for these piping systems through 60 years of operation was determined to be less than the original design limits.

The analyses associated with the containment liner plate and penetrations have been evaluated and determined to remain valid for the period of extended operation, in accordance with 10 CFR 54.21(c)(1)(i).

4.7 OTHER PLANT-SPECIFIC TIME-LIMITED AGING ANALYSES

4.7.1 BOTTOM MOUNTED INSTRUMENTATION THIMBLE TUBE WEAR

As discussed in NRC Information Notice No. 87-44, Supplement 1, "Thimble Tube Thinning in Westinghouse Reactors," thimble tubes have experienced thinning as a result of flow-induced vibration. Thimble tube wear results in degradation of the Reactor Coolant System pressure boundary and could potentially create a non-isolable leak of reactor coolant. Therefore, the NRC staff requested that licensees perform the actions described in NRC Bulletin No. 88-09, "Thimble Tube Thinning in Westinghouse Reactors." In response to this bulletin, Turkey Point established a program for inspection and assessment of thimble tube thinning. Turkey Point commitments to the NRC for two eddy current inspections of the thimble tubes for each unit were completed in May 1990 for Unit 4, and in December 1992 for Unit 3. The results demonstrated that the thimble tubes were acceptable for operation and that no appreciable thinning had occurred between the two inspections. Based on the results of the inspections and the flaw analyses performed, only the Unit 3 thimble tube N-05 will require further evaluation for the extended period of operation.

In order to ensure thimble tube reliability, an inspection of Unit 3 thimble tube N-05 will be conducted under the Thimble Tube Inspection Program, described in Appendix B. This aging management program will ensure that thimble tube thinning will be adequately managed for the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(iii).

4.7.2 EMERGENCY CONTAINMENT COOLER TUBE WEAR

The component cooling water flow rate through the emergency containment coolers could exceed the nominal design flow during certain plant conditions. High flow rates can produce increased wear on the inside surface of the emergency containment cooler coils. The effect of increased wear was previously evaluated and the tube wall nominal thickness was determined to exceed the minimum required wall thickness during the existing operating period of 40 years. In order to ensure emergency containment cooler coil reliability, a one-time inspection for minimum tube wall thickness will be conducted prior to the end of the existing operating period to further assess the actual tube wall thinning. The inspection will be conducted in accordance with the Emergency Containment Coolers Inspection, described in Appendix B.

The Emergency Containment Coolers Inspection will ensure that the aging effect of emergency containment cooler tube wear will be adequately managed for the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(iii).

4.7.3 LEAK-BEFORE-BREAK FOR REACTOR COOLANT SYSTEM PIPING

A plant-specific Leak-Before-Break (LBB) analysis was performed for Turkey Point Units 3 and 4 in 1994. The LBB analysis was performed to show that any potential leaks that develop in the Reactor Coolant System loop piping can be detected by plant monitoring systems before a postulated crack causing the leak would grow to unstable proportions during the 40-year plant life. As documented in the June 23, 1995, NRC letter to FPL [Reference 4.7-1], the NRC approved the Turkey Point LBB analysis. The NRC safety evaluation concluded that the LBB analysis was consistent with the criteria in NUREG-1061, Volume 3, and the draft Standard Review Plan, Section 3.6.3; therefore, the analysis complied with 10 CFR 50, Appendix A, General Design Criterion 4.

The aging effects that must be addressed during the period of extended operation include thermal aging of the primary loop piping components and fatigue crack growth. Thermal aging refers to the gradual change in the microstructure and properties of a material due to its exposure to elevated temperatures for an extended period of time. The only significant thermal aging effect on the Reactor Coolant System loop piping is embrittlement of the duplex ferritic cast austenitic stainless steel components. This effect results in a reduction in fracture toughness of the material.

The LBB analysis for Turkey Point Units 3 and 4 was revised to address the extended period of operation utilizing criteria consistent with the requirements of NUREG-1061, Volume 3, and the draft Standard Review Plan, Section 3.6.3, that the NRC had referenced in their approval of the original LBB analysis. Since the primary loop piping includes cast stainless steel fittings, fully aged fracture toughness properties were determined for each heat of material. Based on loading, pipe geometry, and fracture toughness considerations, enveloping critical locations were determined at which LBB crack stability evaluations were made. Through-wall flaw sizes were postulated at the critical locations that would cause leakage at a rate ten times the leakage detection system capability. Including the requirement for margin of applied loads, large margins against flaw instability were demonstrated for the postulated flaw sizes.

Finally, a plant-specific fatigue crack growth analysis for Turkey Point Units 3 and 4 for a 60-year plant life was performed. A design transient set that bounds the Turkey Point design transients was utilized in the fatigue crack growth analysis. Fatigue crack growth for the period of extended operation is negligible.

The Reactor Coolant System primary loop piping Leak-Before-Break analysis has been projected to the end of the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(ii).

4.7.4 CRANE LOAD CYCLE LIMIT

The load cycle limit for cranes was identified as a time-limited aging analysis. At Turkey Point Units 3 and 4, the following cranes are within the scope of license renewal:

- the spent fuel pool bridge cranes
- the spent fuel cask crane
- the reactor polar cranes
- the reactor cavity manipulator cranes
- the intake structure bridge crane
- the turbine gantry cranes

The spent fuel pool bridge cranes were replaced in 1990. The spent fuel pool bridge cranes are analyzed for up to 200,000 cycles of maximum load. These 200,000 cycles are equivalent to approximately 12.7 cycles-per-day for each spent fuel pool bridge crane through the period of extended operation. Since the actual crane usage factors over their projected lives will be far less than 200,000 cycles, no additional evaluation is required.

The other cranes in the scope of license renewal were analyzed for up to 2,000,000 cycles of maximum load based on the design codes utilized for these cranes. These 2,000,000 cycles are equivalent to approximately 90 cycles-per-day for each crane through the period of extended operation. Since the actual crane usage factors over 60 years will be far less than 2,000,000 cycles, the other cranes in the scope of license renewal will continue to perform their intended function throughout the period of extended operation.

The analyses associated with crane design, including fatigue, remain valid for the period of extended operation, in accordance with the requirements of 10 CFR 54.21(c)(1)(i).

4.7.5 REFERENCES

4.7-1 Richard P. Croteau (NRC) letter to J. H. Goldberg (FPL), "Turkey Point Units 3 and 4 - Approval to Utilize Leak-Before-Break Methodology for Reactor Coolant System Piping," June 23, 1995.