VII AUXILIARY SYSTEMS
E4 Shutdown Cooling System (Older BWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.E4.AP-43	VII.E4-8(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.E4.AP-32	VII.E4-9(AP-32)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.E4.AP-31	VII.E4-10(AP-31)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.E4.AP-186	VII.E4-11(AP-60)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.E4.AP-138	VII.E4-12(AP-59)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, "One-Time Inspection"	No
VII.E4.A-62	VII.E4-13(A-62)	Piping, piping components, and piping elements	Stainless steel	Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
VII.E4.AP-110	VII.E4-14(A-58)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No

VII E4	AUXILIARY SYSTEMS Shutdown Cooling System (Older BWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.E4.A-61	VII.E4-15(A-61)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M7, “BWR Stress Corrosion Cracking,” and Chapter XI.M2, “Water Chemistry”	No
VII.E4.AP-127	VII.E4-16(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.E4.AP-106	VII.E4-17(A-35)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.E4.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.E4.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

E5. WASTE WATER SYSTEMS

Systems, Structures, and Components

This section discusses liquid waste systems such as liquid radioactive waste systems, oily waste systems, floor drainage systems, chemical waste water systems, and secondary waste water systems. Plants may include portions of waste water systems within the scope of license renewal based on the criterion of 10CFR 54.4.(a)(2).

Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” radioactive-waste-containing portions of waste water systems are classified as Group C Quality Standards, with the exception of those forming part of the containment pressure boundary, which is classified as Group B. Waste water systems that do not contain radioactive waste or form a part of the containment pressure boundary are classified as Group D.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are also subject to replacement based on qualified life or specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

Various other systems discussed in this report may interface with waste water systems.

VII	AUXILIARY SYSTEMS						
E5	Wastewater Systems						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.E5.AP-276		Heat exchanger components	Nickel alloy	Waste water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-275		Heat exchanger components	Stainless steel	Waste water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-271		Piping, piping components, and piping elements	Copper alloy	Raw water (potable)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-272		Piping, piping components, and piping elements	Copper alloy	Waste water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-274		Piping, piping components, and piping elements	Nickel alloy	Condensation (Internal)	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

VII AUXILIARY SYSTEMS
E5 Wastewater Systems

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.E5.AP-273		Piping, piping components, and piping elements	Stainless steel	Condensation (Internal)	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-270		Piping, piping components, and piping elements	Steel; stainless steel	Raw water (potable)	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-279		Piping, piping components, and piping elements; tanks	Nickel alloy	Waste water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-278		Piping, piping components, and piping elements; tanks	Stainless steel	Waste water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.E5.AP-280		Piping, piping components, and piping elements; tanks	Steel	Condensation (Internal)	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

VII E5	AUXILIARY SYSTEMS Wastewater Systems						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.E5.AP-281		Piping, piping components, and piping elements; tanks	Steel	Waste water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

F1. CONTROL ROOM AREA VENTILATION SYSTEM

Systems, Structures, and Components

This section discusses the control room area ventilation system (with warm moist air as the normal environment), which contains ducts, piping and fittings, equipment frames and housings, flexible collars and seals, filters, and heating and cooling air handlers. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the control room area ventilation system are governed by Group B Quality Standards.

With respect to filters and seals, these items are to be addressed consistent with the Nuclear Regulatory Commission (NRC) position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system filters and seals are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The system that interfaces with the control room area ventilation system is the auxiliary and radwaste area ventilation system (VII.F2). The cooling coils receive their cooling water from other systems, such as the hot water heating system or the chilled water cooling system.

VII AUXILIARY SYSTEMS
F1 Control Room Area Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F1.AP-99	VII.F1-1(A-09)	Ducting and components	Stainless steel	Condensation	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F1.A-10	VII.F1-2(A-10)	Ducting and components (External surfaces)	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F1.A-08	VII.F1-3(A-08)	Ducting and components (Internal surfaces)	Steel	Condensation (Internal)	Loss of material due to general, pitting, crevice, and (for drip pans and drain lines) microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F1.A-105	VII.F1-4(A-105)	Ducting; closure bolting	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F1.AP-113	VII.F1-5(A-73)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (External)	Loss of material due to wear	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F1.AP-103	VII.F1-6(A-18)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal)	Loss of material due to wear	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F1.AP-102	VII.F1-7(A-17)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal/External)	Hardening and loss of strength due to elastomer degradation	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII AUXILIARY SYSTEMS
F1 Control Room Area Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F1.AP-203	VII.F1-8(AP-34)	Heat exchanger components	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F1.AP-65	VII.F1-9(AP-65)	Heat exchanger components	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F1.AP-41	VII.F1-10(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F1.AP-189	VII.F1-11(A-63)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F1.AP-205	VII.F1-12(AP-80)	Heat exchanger tubes	Copper alloy	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F1.AP-204	VII.F1-13(AP-77)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F1.AP-142	VII.F1-14(AP-74)	Piping, piping components, and piping elements	Aluminum	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F1.AP-199	VII.F1-15(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

VII AUXILIARY SYSTEMS
F1 Control Room Area Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F1.AP-109	VII.F1-16(A-46)	Piping, piping components, and piping elements	Copper alloy	Condensation (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F1.AP-43	VII.F1-17(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.F1.AP-31	VII.F1-18(AP-31)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.F1.AP-127	VII.F1-19(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, "One-Time Inspection"	No
VII.F1.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F1.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F1.AP-202	VII.F1-20(A-25)	Piping, piping components, and piping elements; tanks	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

F2. Auxiliary and Radwaste Area Ventilation System

Systems, Structures, and Components

This section discusses the auxiliary and radwaste area ventilation systems (with warm moist air as the normal environment) and contains ducts, piping and fittings, equipment frames and housings, flexible collars and seals, filters, and heating and cooling air handlers. Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” all components that comprise the auxiliary and radwaste area ventilation system are governed by Group B Quality Standards.

With respect to filters and seals, these items are to be addressed consistent with the NRC position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system filters and seals are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the auxiliary and radwaste area ventilation system are the control room area ventilation system (VII.F1) and the diesel generator building ventilation system (VII.F4). The cooling coils receive their cooling water from other systems, such as the hot water heating system or the chilled water cooling system.

VII AUXILIARY SYSTEMS
F2 Auxiliary and Radwaste Area Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F2.AP-99	VII.F2-1(A-09)	Ducting and components	Stainless steel	Condensation	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F2.A-10	VII.F2-2(A-10)	Ducting and components (External surfaces)	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F2.A-08	VII.F2-3(A-08)	Ducting and components (Internal surfaces)	Steel	Condensation (Internal)	Loss of material due to general, pitting, crevice, and (for drip pans and drain lines) microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F2.A-105	VII.F2-4(A-105)	Ducting; closure bolting	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F2.AP-113	VII.F2-5(A-73)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (External)	Loss of material due to wear	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F2.AP-103	VII.F2-6(A-18)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal)	Loss of material due to wear	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F2.AP-102	VII.F2-7(A-17)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal/External)	Hardening and loss of strength due to elastomer degradation	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII AUXILIARY SYSTEMS
F2 Auxiliary and Radwaste Area Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F2.AP-41	VII.F2-8(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F2.AP-189	VII.F2-9(A-63)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F2.AP-205	VII.F2-10(AP-80)	Heat exchanger tubes	Copper Alloy	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F2.AP-204	VII.F2-11(AP-77)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F2.AP-142	VII.F2-12(AP-74)	Piping, piping components, and piping elements	Aluminum	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F2.AP-199	VII.F2-13(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F2.AP-109	VII.F2-14(A-46)	Piping, piping components, and piping elements	Copper alloy	Condensation (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F2.AP-43	VII.F2-15(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No

VII	AUXILIARY SYSTEMS						
F2	Auxiliary and Radwaste Area Ventilation System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.F2.AP-31	VII.F2-16(AP-31)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VII.F2.AP-127	VII.F2-17(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, "One-Time Inspection"	No
VII.F2.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F2.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F2.AP-202	VII.F2-18(A-25)	Piping, piping components, and piping elements; tanks	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

F3. PRIMARY CONTAINMENT HEATING AND VENTILATION SYSTEM

Systems, Structures, and Components

This section discusses the primary containment heating and ventilation system (with warm moist air as the normal environment), which contains ducts, piping and fittings, equipment frames and housings, flexible collars and seals, filters, and heating and cooling air handlers. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the primary containment heating and ventilation system are governed by Group C Quality Standards.

With respect to filters and seals, these items are to be addressed consistent with the Nuclear Regulatory Commission (NRC) position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system filters and seals are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the primary containment heating and ventilation system are the closed-cycle cooling water system (VII.C2) and the PWR and BWR containments (II.A and II.B, respectively). The cooling coils receive their cooling water from other systems, such as the hot water heating system or the chilled water cooling system.

VII AUXILIARY SYSTEMS
F3 Primary Containment Heating and Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F3.AP-99	VII.F3-1(A-09)	Ducting and components	Stainless steel	Condensation	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F3.A-10	VII.F3-2(A-10)	Ducting and components (External surfaces)	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F3.A-08	VII.F3-3(A-08)	Ducting and components (Internal surfaces)	Steel	Condensation (Internal)	Loss of material due to general, pitting, crevice, and (for drip pans and drain lines) microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F3.A-105	VII.F3-4(A-105)	Ducting; closure bolting	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F3.AP-113	VII.F3-5(A-73)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (External)	Loss of material due to wear	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F3.AP-103	VII.F3-6(A-18)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal)	Loss of material due to wear	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F3.AP-102	VII.F3-7(A-17)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal/External)	Hardening and loss of strength due to elastomer degradation	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII AUXILIARY SYSTEMS F3 Primary Containment Heating and Ventilation System							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.F3.AP-203	VII.F3-8(AP-34)	Heat exchanger components	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F3.AP-65	VII.F3-9(AP-65)	Heat exchanger components	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F3.AP-41	VII.F3-10(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F3.AP-189	VII.F3-11(A-63)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F3.AP-205	VII.F3-12(AP-80)	Heat exchanger tubes	Copper Alloy	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F3.AP-204	VII.F3-13(AP-77)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F3.AP-142	VII.F3-14(AP-74)	Piping, piping components, and piping elements	Aluminum	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F3.AP-199	VII.F3-15(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

VII AUXILIARY SYSTEMS
F3 Primary Containment Heating and Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F3.AP-109	VII.F3-16(A-46)	Piping, piping components, and piping elements	Copper alloy	Condensation (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F3.AP-43	VII.F3-17(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F3.A-50	VII.F3-18(A-50)	Piping, piping components, and piping elements	Gray cast iron	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F3.AP-127	VII.F3-19(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.F3.AP-202	VII.F3-20(A-25)	Piping, piping components, and piping elements; tanks	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

F4. DIESEL GENERATOR BUILDING VENTILATION SYSTEM

Systems, Structures, and Components

This section discusses the diesel generator building ventilation system (with warm moist air as the normal environment), which contains ducts, piping and fittings, equipment frames and housings, flexible collars and seals, and heating and cooling air handlers. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the diesel generator building ventilation system are governed by Group C Quality Standards.

With respect to filters and seals, these items are to be addressed consistent with the Nuclear Regulatory Commission (NRC) position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system seals are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The system that interfaces with the diesel generator building system is the auxiliary and radwaste area ventilation system (VII.F2). The cooling coils receive their cooling water from other systems, such as the hot water heating system or the chilled water cooling system.

VII AUXILIARY SYSTEMS
F4 Diesel Generator Building Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F4.A-10	VII.F4-1(A-10)	Ducting and components (External surfaces)	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F4.A-08	VII.F4-2(A-08)	Ducting and components (Internal surfaces)	Steel	Condensation (Internal)	Loss of material due to general, pitting, crevice, and (for drip pans and drain lines) microbiologically-influenced corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F4.A-105	VII.F4-3(A-105)	Ducting; closure bolting	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F4.AP-113	VII.F4-4(A-73)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (External)	Loss of material due to wear	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F4.AP-103	VII.F4-5(A-18)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal)	Loss of material due to wear	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F4.AP-102	VII.F4-6(A-17)	Elastomer: seals and components	Elastomers	Air – indoor, uncontrolled (Internal/External)	Hardening and loss of strength due to elastomer degradation	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F4.AP-41	VII.F4-7(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII AUXILIARY SYSTEMS
F4 Diesel Generator Building Ventilation System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.F4.AP-189	VII.F4-8(A-63)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F4.AP-204	VII.F4-9(AP-77)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F4.AP-142	VII.F4-10(AP-74)	Piping, piping components, and piping elements	Aluminum	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.F4.AP-199	VII.F4-11(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.F4.AP-109	VII.F4-12(A-46)	Piping, piping components, and piping elements	Copper alloy	Condensation (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.F4.AP-43	VII.F4-13(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F4.AP-31	VII.F4-14(AP-31)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.F4.AP-127	VII.F4-15(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VII F4	AUXILIARY SYSTEMS Diesel Generator Building Ventilation System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.F4.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F4.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.F4.AP-202	VII.F4-16(A-25)	Piping, piping components, and piping elements; tanks	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

G. FIRE PROTECTION

Systems, Structures, and Components

This section discusses the fire protection systems for both boiling water reactors (BWRs) and pressurized water reactors (PWRs), which consist of several Class 1 structures, mechanical systems, and electrical components. The Class 1 structures include the intake structure, the turbine building, the auxiliary building, the diesel generator building, and the primary containment. Structural components include fire barrier walls, ceilings, floors, fire doors, and penetration seals. Mechanical systems include the high pressure service water system, the reactor coolant pump oil collect system, and the diesel fire system. Mechanical components include piping and fittings, filters, fire hydrants, mulsifiers, pumps, sprinklers, strainers, and valves (including containment isolation valves). Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the fire protection system are governed by Group C Quality Standards.

With respect to filters, seals, portable fire extinguishers, and fire hoses, these items are to be addressed consistent with the NRC position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system filters, seals, portable fire extinguishers, and fire hoses are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are also subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems and structures that interface with the fire protection system include various Class 1 structures and component supports (III.A and III.B), the electrical components (VI.A and VI.B), the closed-cycle cooling water system (VII.C2), and the diesel fuel oil system (VII.H1).

VII AUXILIARY SYSTEMS
G Fire Protection

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.G.A-19	VII.G-1(A-19)	Fire barrier penetration seals	Elastomers	Air - indoor, uncontrolled	Increased hardness; shrinkage; loss of strength due to weathering	Chapter XI.M26, "Fire Protection"	No
VII.G.A-20	VII.G-2(A-20)	Fire barrier penetration seals	Elastomers	Air – outdoor	Increased hardness; shrinkage; loss of strength due to weathering	Chapter XI.M26, "Fire Protection"	No
VII.G.AP-149		Fire Hydrants	Steel	Air – outdoor	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.A-21	VII.G-3(A-21)	Fire rated doors	Steel	Air - indoor, uncontrolled	Loss of material due to wear	Chapter XI.M26, "Fire Protection"	No
VII.G.A-22	VII.G-4(A-22)	Fire rated doors	Steel	Air – outdoor	Loss of material due to wear	Chapter XI.M26, "Fire Protection"	No
VII.G.AP-150		Halon/carbon dioxide fire suppression system piping, piping components, and piping elements	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M26, "Fire Protection"	No
VII.G.AP-41	VII.G-5(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII G	AUXILIARY SYSTEMS Fire Protection						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.AP-40	VII.G-6(AP-40)	Heat exchanger components	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.G.AP-187	VII.G-7(AP-61)	Heat exchanger tubes	Stainless steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VII.G.AP-180	VII.G-8(AP-83)	Piping, piping components, and piping elements	Aluminum	Raw water	Loss of material due to pitting and crevice corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.AP-143	VII.G-9(AP-78)	Piping, piping components, and piping elements	Copper alloy	Condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.G.AP-132	VII.G-10(AP-44)	Piping, piping components, and piping elements	Copper alloy	Fuel oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.G.AP-133	VII.G-11(AP-47)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.G.AP-197	VII.G-12(A-45)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No

VII AUXILIARY SYSTEMS G Fire Protection							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.A-47	VII.G-13(A-47)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.G.A-51	VII.G-14(A-51)	Piping, piping components, and piping elements	Gray cast iron	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.G.A-02	VII.G-15(A-02)	Piping, piping components, and piping elements	Gray cast iron	Soil	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.G.AP-31	VII.G-16(AP-31)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.G.AP-136	VII.G-17(AP-54)	Piping, piping components, and piping elements	Stainless steel	Fuel oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.G.AP-138	VII.G-18(AP-59)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.G.A-55	VII.G-19(A-55)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting and crevice corrosion; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.AP-137	VII.G-20(AP-56)	Piping, piping components, and piping elements	Stainless steel	Soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No

VII	AUXILIARY SYSTEMS						
G	Fire Protection						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.AP-234	VII.G-21(A-28)	Piping, piping components, and piping elements	Steel	Fuel oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M30, "Fuel Oil Chemistry", and Chapter XI.M32, "One-Time Inspection"	No
VII.G.AP-127	VII.G-22(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.G.A-23	VII.G-23(A-23)	Piping, piping components, and piping elements	Steel	Moist air or condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.G.A-33	VII.G-24(A-33)	Piping, piping components, and piping elements	Steel	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M27, "Fire Water System"	No
VII.G.AP-198	VII.G-25(A-01)	Piping, piping components, and piping elements	Steel (with coating or wrapping)	Soil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.G.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

VII	AUXILIARY SYSTEMS						
G	Fire Protection						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.G.AP-117	VII.G-26(A-83)	Reactor coolant pump oil collection system: piping, tubing, valve bodies	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.G.AP-116	VII.G-27(A-82)	Reactor coolant pump oil collection system: tanks	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.G.A-90	VII.G-28(A-90)	Structural fire barriers: walls, ceilings and floors	Reinforced concrete	Air - indoor, uncontrolled	Concrete cracking and spalling due to aggressive chemical attack, and reaction with aggregates	Chapter XI.M26, “Fire Protection,” and Chapter XI.S6, “Structures Monitoring”	No
VII.G.A-91	VII.G-29(A-91)	Structural fire barriers: walls, ceilings and floors	Reinforced concrete	Air - indoor, uncontrolled	Loss of material due to corrosion of embedded steel	Chapter XI.M26, “Fire Protection,” and Chapter XI.S6, “Structures Monitoring”	No
VII.G.A-92	VII.G-30(A-92)	Structural fire barriers: walls, ceilings and floors	Reinforced concrete	Air – outdoor	Cracking, loss of material due to freeze-thaw, aggressive chemical attack, and reaction with aggregates	Chapter XI.M26, “Fire Protection,” and Chapter XI.S6, “Structures Monitoring”	No

VII AUXILIARY SYSTEMS G Fire Protection							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.G.A-93	VII.G-31(A-93)	Structural fire barriers: walls, ceilings and floors	Reinforced concrete	Air – outdoor	Loss of material due to corrosion of embedded steel	Chapter XI.M26, “Fire Protection,” and Chapter XI.S6, “Structures Monitoring”	No

H1. DIESEL FUEL OIL SYSTEM

Systems, Structures, and Components

This section discusses the diesel fuel oil system, which consists of aboveground and underground piping, valves, pumps, and tanks. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the diesel fuel oil system are governed by Group C Quality Standards.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the diesel fuel oil system are the fire protection (VII.G) and emergency diesel generator systems (VII.H2).

VII AUXILIARY SYSTEMS
H1 Diesel Fuel Oil System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H1.AP-129	VII.H1-1(AP-35)	Piping, piping components, and piping elements	Aluminum	Fuel oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H1.AP-199	VII.H1-2(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.H1.AP-132	VII.H1-3(AP-44)	Piping, piping components, and piping elements	Copper alloy	Fuel oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H1.AP-43	VII.H1-4(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H1.A-02	VII.H1-5(A-02)	Piping, piping components, and piping elements	Gray cast iron	Soil	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H1.AP-136	VII.H1-6(AP-54)	Piping, piping components, and piping elements	Stainless steel	Fuel oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

VII AUXILIARY SYSTEMS
H1 Diesel Fuel Oil System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H1.AP-137	VII.H1-7(AP-56)	Piping, piping components, and piping elements	Stainless steel	Soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.H1.A-24	VII.H1-8(A-24)	Piping, piping components, and piping elements	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.H1.AP-198	VII.H1-9(A-01)	Piping, piping components, and piping elements	Steel (with coating or wrapping)	Soil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.H1.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.H1.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.H1.AP-105	VII.H1-10(A-30)	Piping, piping components, and piping elements; tanks	Steel	Fuel oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M30, "Fuel Oil Chemistry," and Chapter XI.M32, "One-Time Inspection"	No

VII AUXILIARY SYSTEMS
H1 Diesel Fuel Oil System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H1.A-95	VII.H1-11(A-95)	Tanks	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, "Aboveground Metallic Tanks"	No

H2. EMERGENCY DIESEL GENERATOR SYSTEM

Systems, Structures, and Components

This section discusses the emergency diesel generator system, which contains piping, valves, filters, mufflers, strainers, and tanks. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the emergency diesel generator system are governed by Group C Quality Standards.

With respect to filters and seals, these items are to be addressed consistent with the NRC position on consumables, provided in the NRC letter from Christopher I. Grimes to Douglas J. Walters of the Nuclear Energy Institute (NEI), dated March 10, 2000. Specifically, components that function as system filters are typically replaced based on performance or condition monitoring that identifies whether these components are at the end of their qualified lives and may be excluded, on a plant-specific basis, from an aging management review under 10 CFR 54.21(a)(1)(ii). As part of the methodology description, the application should identify the standards that are relied on for replacement, for example, National Fire Protection Association (NFPA) standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VII.I. Common miscellaneous material/environment combinations where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation are included in VII.J.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the emergency diesel generator system include the diesel fuel oil system (VII.H1), the closed-cycle cooling water system (VII.C2) and the open-cycle cooling water system (VII.C1) for some plants.

VII	AUXILIARY SYSTEMS						
H2	Emergency Diesel Generator System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.H2.AP-128	VII.H2-1(AP-33)	Diesel engine exhaust piping, piping components, and piping elements	Stainless steel	Diesel exhaust	Cracking due to stress corrosion cracking	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.H2.AP-41	VII.H2-3(AP-41)	Heat exchanger components	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.H2.AP-40	VII.H2-4(AP-40)	Heat exchanger components	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.H2.AP-131	VII.H2-5(AP-39)	Heat exchanger components	Steel	Lubricating oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-154		Heat exchanger tubes	Aluminum	Lubricating oil	Reduction of heat transfer due to fouling	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-187	VII.H2-6(AP-61)	Heat exchanger tubes	Stainless steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VII.H2.AP-255		Piping, piping components, and piping elements	Aluminum	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

VII AUXILIARY SYSTEMS
H2 Emergency Diesel Generator System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H2.AP-129	VII.H2-7(AP-35)	Piping, piping components, and piping elements	Aluminum	Fuel oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-162		Piping, piping components, and piping elements	Aluminum	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-258		Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-199	VII.H2-8(AP-12)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.H2.AP-132	VII.H2-9(AP-44)	Piping, piping components, and piping elements	Copper alloy	Fuel oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-133	VII.H2-10(AP-47)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VII AUXILIARY SYSTEMS
H2 Emergency Diesel Generator System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H2.AP-193	VII.H2-11(AP-45)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VII.H2.AP-43	VII.H2-12(AP-43)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H2.A-47	VII.H2-13(A-47)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H2.A-51	VII.H2-14(A-51)	Piping, piping components, and piping elements	Gray cast iron	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H2.A-02	VII.H2-15(A-02)	Piping, piping components, and piping elements	Gray cast iron	Soil	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VII.H2.AP-136	VII.H2-16(AP-54)	Piping, piping components, and piping elements	Stainless steel	Fuel oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.AP-138	VII.H2-17(AP-59)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VII AUXILIARY SYSTEMS H2 Emergency Diesel Generator System							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.H2.AP-55	VII.H2-18(AP-55)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VII.H2.AP-137	VII.H2-19(AP-56)	Piping, piping components, and piping elements	Stainless steel	Soil	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.H2.AP-127	VII.H2-20(AP-30)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VII.H2.A-23	VII.H2-21(A-23)	Piping, piping components, and piping elements	Steel	Moist air or condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VII.H2.AP-194	VII.H2-22(A-38)	Piping, piping components, and piping elements	Steel (with coating or lining)	Raw water	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion; lining/coating degradation	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VII.H2.AP-104	VII.H2-2(A-27)	Piping, piping components, and piping elements, diesel engine exhaust	Steel; stainless steel	Diesel exhaust	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

VII AUXILIARY SYSTEMS
H2 Emergency Diesel Generator System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.H2.AP-209		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.H2.AP-221		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VII.H2.AP-202	VII.H2-23(A-25)	Piping, piping components, and piping elements; tanks	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VII.H2.AP-105	VII.H2-24(A-30)	Piping, piping components, and piping elements; tanks	Steel	Fuel oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M30, “Fuel Oil Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

I. EXTERNAL SURFACES OF COMPONENTS AND MISCELLANEOUS BOLTING

Systems, Structures, and Components

This section addresses the aging management programs for the external surfaces of all steel structures and components, including closure bolting in the Auxiliary Systems in pressurized water reactors (PWRs) and boiling water reactors (BWRs). For the steel components in PWRs, this section addresses only boric acid corrosion of external surface as a result of dripping borated water that is leaking from an adjacent PWR component. Boric acid corrosion can also occur for steel components containing borated water due to leakage; such components and the related aging management program are covered in the appropriate major plant sections in VII.

System Interfaces

The structures and components covered in this section belong to the Auxiliary Systems in PWRs and BWRs. (For example, see System Interfaces in VII.A1 to VII.H2 for details.)

VII	AUXILIARY SYSTEMS						
I	External Surfaces of Components and Miscellaneous Bolting						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.I.AP-261		Bolting	Copper alloy	Any environment	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-262		Bolting	Nickel alloy	Any environment	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-243		Bolting	Stainless steel	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.I.AP-244		Bolting	Stainless steel	Soil	Loss of preload	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-265		Bolting	Stainless steel	Treated borated water	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.A-102	VII.I-2(A-102)	Bolting	Steel	Air with borated water leakage	Loss of material due to boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
VII.I.AP-241		Bolting	Steel	Soil or concrete	Loss of material due to general, pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VII.I.AP-242		Bolting	Steel	Soil	Loss of preload	Chapter XI.M18, "Bolting Integrity"	No

VII AUXILIARY SYSTEMS
I External Surfaces of Components and Miscellaneous Bolting

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.I.AP-126	VII.I-1(AP-28)	Bolting	Steel; stainless steel	Air – outdoor (External)	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-263		Bolting	Steel; stainless steel	Air – outdoor (External)	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-266		Bolting	Steel; stainless steel	Fuel oil	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-264		Bolting	Steel; stainless steel	Raw water	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-267		Bolting	Steel; stainless steel	Treated water	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.A-03	VII.I-6(A-03)	Closure bolting	Steel	Air with steam or water leakage	Loss of material due to general corrosion	Chapter XI.M18, "Bolting Integrity"	No
VII.I.A-04	VII.I-3(A-04)	Closure bolting	Steel, high-strength	Air with steam or water leakage	Cracking due to stress corrosion cracking; cyclic loading	Chapter XI.M18, "Bolting Integrity"	No

VII I	AUXILIARY SYSTEMS External Surfaces of Components and Miscellaneous Bolting						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.I.AP-125	VII.I-4(AP-27)	Closure bolting	Steel; stainless steel	Air – indoor, uncontrolled (External)	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M18, "Bolting Integrity"	No
VII.I.AP-124	VII.I-5(AP-26)	Closure bolting	Steel; stainless steel	Air – indoor, uncontrolled (External)	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VII.I.A-105	VII.I-7(A-105)	Ducting; closure bolting	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.I.A-77	VII.I-8(A-77)	External surfaces	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.I.A-78	VII.I-9(A-78)	External surfaces	Steel	Air – outdoor (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.I.A-79	VII.I-10(A-79)	External surfaces	Steel	Air with borated water leakage	Loss of material due to boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
VII.I.A-81	VII.I-11(A-81)	External surfaces	Steel	Condensation (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.I.AP-256		Piping, piping components, and piping elements	Aluminum	Air - outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No

VII I	AUXILIARY SYSTEMS External Surfaces of Components and Miscellaneous Bolting						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.I.AP-159		Piping, piping components, and piping elements	Copper alloy	Air – outdoor (External)	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VII.I.AP-66	VII.I-12(AP-66)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Air with borated water leakage	Loss of material due to boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
VII.I.AP-284		Underground piping, piping components, and piping elements	Steel; stainless steel; copper alloy; aluminum	Air-indoor uncontrolled or condensation (external)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No

J. COMMON MISCELLANEOUS MATERIAL/ENVIRONMENT COMBINATIONS

Systems, Structures, and Components

This section addresses the aging management programs for miscellaneous material/environment combinations which may be found throughout structures and components for auxiliary systems. For the material/environment combinations in this part, aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation. Therefore, no resulting aging management programs for these structures and components are required.

System Interfaces

The structures and components covered in this section belong to the auxiliary systems in pressurized water reactors (PWRs) and boiling water reactors (BWRs). (For example, see System Interfaces in VII.A to VII.I for details.)

VII	AUXILIARY SYSTEMS
J	Common Miscellaneous Material/Environment Combinations

Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VII.J.AP-151		Heat exchanger components	Titanium	Air – indoor, uncontrolled or Air – outdoor	None	None	No
VII.J.AP-48	VII.J-7(AP-48)	Piping elements	Glass	Air	None	None	No
VII.J.AP-14	VII.J-8(AP-14)	Piping elements	Glass	Air – indoor, uncontrolled (External)	None	None	No
VII.J.AP-167		Piping elements	Glass	Air – outdoor	None	None	No
VII.J.AP-96		Piping elements	Glass	Air with borated water leakage	None	None	No
VII.J.AP-166		Piping elements	Glass	Closed-cycle cooling water	None	None	No
VII.J.AP-97		Piping elements	Glass	Condensation (Internal/External)	None	None	No
VII.J.AP-49	VII.J-9(AP-49)	Piping elements	Glass	Fuel oil	None	None	No
VII.J.AP-98		Piping elements	Glass	Gas	None	None	No

VII AUXILIARY SYSTEMS
J Common Miscellaneous Material/Environment Combinations

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.J.AP-15	VII.J-10(AP-15)	Piping elements	Glass	Lubricating oil	None	None	No
VII.J.AP-50	VII.J-11(AP-50)	Piping elements	Glass	Raw water	None	None	No
VII.J.AP-52	VII.J-12(AP-52)	Piping elements	Glass	Treated borated water	None	None	No
VII.J.AP-51	VII.J-13(AP-51)	Piping elements	Glass	Treated water	None	None	No
VII.J.AP-36	VII.J-1(AP-36)	Piping, piping components, and piping elements	Aluminum	Air – indoor, controlled (External)	None	None	No
VII.J.AP-134		Piping, piping components, and piping elements	Aluminum	Air – dry (Internal/External)	None	None	No
VII.J.AP-135		Piping, piping components, and piping elements	Aluminum	Air – indoor, uncontrolled (Internal/External)	None	None	No
VII.J.AP-37	VII.J-2(AP-37)	Piping, piping components, and piping elements	Aluminum	Gas	None	None	No

VII AUXILIARY SYSTEMS
J Common Miscellaneous Material/Environment Combinations

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.J.AP-8	VII.J-3(AP-8)	Piping, piping components, and piping elements	Copper alloy	Air – dry	None	None	No
VII.J.AP-144		Piping, piping components, and piping elements	Copper alloy	Air – indoor, uncontrolled (Internal/External)	None	None	No
VII.J.AP-9	VII.J-4(AP-9)	Piping, piping components, and piping elements	Copper alloy	Gas	None	None	No
VII.J.AP-11	VII.J-5(AP-11)	Piping, piping components, and piping elements	Copper alloy (≤15% Zn and ≤8% Al)	Air with borated water leakage	None	None	No
VII.J.AP-13	VII.J-6(AP-13)	Piping, piping components, and piping elements	Galvanized steel	Air - indoor, uncontrolled	None	None	No
VII.J.AP-277		Piping, piping components, and piping elements	Glass	Waste water	None	None	No
VII.J.AP-16	VII.J-14(AP-16)	Piping, piping components, and piping elements	Nickel alloy	Air – indoor, uncontrolled (External)	None	None	No
VII.J.AP-260		Piping, piping components, and piping elements	Nickel alloy	Air with borated water leakage	None	None	No

VII AUXILIARY SYSTEMS
J Common Miscellaneous Material/Environment Combinations

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.J.AP-268		Piping, piping components, and piping elements	PVC	Air – indoor, uncontrolled	None	None	No
VII.J.AP-269		Piping, piping components, and piping elements	PVC	Condensation (Internal)	None	None	No
VII.J.AP-20	VII.J-18(AP-20)	Piping, piping components, and piping elements	Stainless steel	Air – dry	None	None	No
VII.J.AP-17	VII.J-15(AP-17)	Piping, piping components, and piping elements	Stainless steel	Air – indoor, uncontrolled (External)	None	None	No
VII.J.AP-123		Piping, piping components, and piping elements	Stainless steel	Air – indoor, uncontrolled (Internal/External)	None	None	No
VII.J.AP-18	VII.J-16(AP-18)	Piping, piping components, and piping elements	Stainless steel	Air with borated water leakage	None	None	No
VII.J.AP-19	VII.J-17(AP-19)	Piping, piping components, and piping elements	Stainless steel	Concrete	None	None	No
VII.J.AP-22	VII.J-19(AP-22)	Piping, piping components, and piping elements	Stainless steel	Gas	None	None	No

VII AUXILIARY SYSTEMS
J Common Miscellaneous Material/Environment Combinations

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VII.J.AP-4	VII.J-22(AP-4)	Piping, piping components, and piping elements	Steel	Air – dry	None	None	No
VII.J.AP-2	VII.J-20(AP-2)	Piping, piping components, and piping elements	Steel	Air – indoor, controlled (External)	None	None	No
VII.J.AP-282	VII.J-21(AP-3)	Piping, piping components, and piping elements	Steel	Concrete	None	None, provided 1) attributes of the concrete are consistent with ACI 318 or ACI 349 (low water-to-cement ratio, low permeability, and adequate air entrainment) as cited in NUREG-1557, and 2) plant OE indicates no degradation of the concrete	No, if conditions are met.
VII.J.AP-6	VII.J-23(AP-6)	Piping, piping components, and piping elements	Steel	Gas	None	None	No
VII.J.AP-160		Piping, piping components, and piping elements	Titanium	Air – indoor, uncontrolled or Air – outdoor	None	None	No

CHAPTER VIII

STEAM AND POWER CONVERSION SYSTEM

MAJOR PLANT SECTIONS

A. Steam Turbine System

B1. Main Steam System (PWR)

B2. Main Steam System (BWR)

C. Extraction Steam System

D1. Feedwater System (PWR)

D2. Feedwater System (BWR)

E. Condensate System

F. Steam Generator Blowdown System (PWR)

G. Auxiliary Feedwater System (PWR)

H. External Surfaces of Components and Miscellaneous Bolting

I. Common Miscellaneous Material/Environment Combinations

A. STEAM TURBINE SYSTEM

Systems, Structures, and Components

This section addresses the piping and fittings in the steam turbine system for both pressurized water reactors (PWRs) and boiling water reactors (BWRs) and consists of the lines from the high-pressure (HP) turbine to the moisture separator/reheater (MSR) and the lines from the MSR to the low-pressure (LP) turbine. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the steam turbine system are governed by Group D Quality Standards.

The steam turbine performs its intended functions with moving parts. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.2(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the steam turbine system include the PWR and BWR main steam system (VIII.B1 and VIII.B2), the extraction steam system (VIII.C), and the condensate system (VIII.E).

VIII A	STEAM AND POWER CONVERSION SYSTEM Steam Turbine System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.A.S-23	VIII.A-1(S-23)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.A.SP-64	VIII.A-2(SP-64)	Heat exchanger components and tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.A.SP-92	VIII.A-3(SP-32)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, "One-Time Inspection"	No
VIII.A.SP-31	VIII.A-4(SP-31)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.A.SP-101	VIII.A-5(SP-61)	Piping, piping components, and piping elements	Copper alloy	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.A.SP-30	VIII.A-6(SP-30)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VIII.A.SP-28	VIII.A-7(SP-28)	Piping, piping components, and piping elements	Gray cast iron	Raw water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No

VIII STEAM AND POWER CONVERSION SYSTEM
A Steam Turbine System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.A.SP-27	VIII.A-8(SP-27)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.A.SP-95	VIII.A-9(SP-38)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.A.SP-98	VIII.A-11(SP-45)	Piping, piping components, and piping elements	Stainless steel	Steam	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.A.SP-155	VIII.A-12(SP-43)	Piping, piping components, and piping elements	Stainless steel	Steam	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.A.SP-91	VIII.A-14(SP-25)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.A.SP-71	VIII.A-15(S-04)	Piping, piping components, and piping elements	Steel	Steam	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.A.S-15	VIII.A-17(S-15)	Piping, piping components, and piping elements	Steel	Steam	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No

VIII A	STEAM AND POWER CONVERSION SYSTEM Steam Turbine System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.A.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.A.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

B1. MAIN STEAM SYSTEM (PWR)

Systems, Structures, and Components

This section addresses the main steam system for pressurized water reactors (PWRs). The section includes the main steam lines from the steam generator to the steam turbine and the turbine bypass lines from the main steam lines to the condenser. Also included are the lines to the main feedwater (FW) and auxiliary feedwater (AFW) pump turbines, steam drains, and valves, including the containment isolation valves on the main steam lines and the lines to the AFW pump turbines.

Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” the portion of the main steam system extending from the steam generator up to the second containment isolation valve is governed by Group B or C Quality Standards, and all other components that comprise the main steam system located downstream of these isolation valves are governed by Group D Quality Standards.

The internals of the valves perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems and structures that interface with the main steam system include PWR concrete or steel containment structures (II.A1 and II.A2), common components (II.A3), the steam generator (IV.D1 and IV.D2), the steam turbine system (VIII.A), the feedwater system (VIII.D1), the condensate system (VIII.E), and the auxiliary feedwater system (VIII.G).

VIII STEAM AND POWER CONVERSION SYSTEM
B1 Main Steam System (PWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.B1.SP-157	VIII.B1-1(SP-18)	Piping, piping components, and piping elements	Nickel alloy	Steam	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-110		Piping, piping components, and piping elements	Stainless steel	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VIII.B1.SP-98	VIII.B1-2(SP-44)	Piping, piping components, and piping elements	Stainless steel	Steam	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-155	VIII.B1-3(SP-43)	Piping, piping components, and piping elements	Stainless steel	Steam	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-87	VIII.B1-4(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-88	VIII.B1-5(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-59	VIII.B1-6(SP-59)	Piping, piping components, and piping elements	Steel	Air – outdoor (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VIII.B1.SP-60	VIII.B1-7(SP-60)	Piping, piping components, and piping elements	Steel	Condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

VIII B1	STEAM AND POWER CONVERSION SYSTEM Main Steam System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.B1.SP-71	VIII.B1-8(S-07)	Piping, piping components, and piping elements	Steel	Steam	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.S-15	VIII.B1-9(S-15)	Piping, piping components, and piping elements	Steel	Steam	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No
VIII.B1.S-08	VIII.B1-10(S-08)	Piping, piping components, and piping elements	Steel	Steam or Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 “Metal Fatigue,” for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
VIII.B1.SP-74	VIII.B1-11(S-10)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B1.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.B1.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

B2. MAIN STEAM SYSTEM (BWR)

Systems, Structures, and Components

This section addresses the main steam system for boiling water reactors (BWRs). The section includes the main steam lines from the outermost containment isolation valve to the steam turbines and the turbine bypass lines from the main steam lines to the condenser. Also included are steam drains, lines to the main feedwater (FW), high-pressure coolant injection (HPCI), and reactor core isolation cooling (RCIC) turbines.

Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," portions of the main steam system extending from the outermost containment isolation valve up to and including the turbine stop and bypass valves, as well as connected piping up to and including the first valve that is either normally closed or capable of automatic closure during all modes of normal reactor operation, are governed by Group B Quality Standards. The remaining portions of the main steam system consist of components governed by Group D Quality Standards. For BWRs containing a shutoff valve in addition to the two containment isolation valves in the main steam line, Group B Quality Standards apply only to those portions of the system extending from the outermost containment isolation valves up to and including the shutoff valve. The portion of the main steam system extending from the reactor pressure vessel up to the second isolation valve and including the containment isolation valves is governed by Group A Quality Standards, and is covered in IV.C1.

The internal of the valves perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the main steam system include the BWR Mark 1, Mark 2, or Mark 3 containment structures (II.B1, II.B2, and II.B3, respectively) and common components (II.B4), the reactor coolant pressure boundary (IV.C1), the steam turbine system (VIII.A), the feedwater system (VIII.D2), and the condensate system (VIII.E).

VIII STEAM AND POWER CONVERSION SYSTEM B2 Main Steam System (BWR)							
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.B2.SP-110		Piping, piping components, and piping elements	Stainless steel	Condensation (Internal)	Loss of material due to pitting and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VIII.B2.SP-98	VIII.B2-1(SP-45)	Piping, piping components, and piping elements	Stainless steel	Steam	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B2.SP-155	VIII.B2-2(SP43)	Piping, piping components, and piping elements	Stainless steel	Steam	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B2.SP-160	VIII.B2-3(S-05)	Piping, piping components, and piping elements	Steel	Steam	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.B2.S-15	VIII.B2-4(S-15)	Piping, piping components, and piping elements	Steel	Steam	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No
VIII.B2.S-08	VIII.B2-5(S-08)	Piping, piping components, and piping elements	Steel	Steam or Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 “Metal Fatigue,” for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
VIII.B2.SP-73	VIII.B2-6(S-09)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

VIII B2	STEAM AND POWER CONVERSION SYSTEM Main Steam System (BWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.B2.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.B2.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

C. EXTRACTION STEAM SYSTEM

Systems, Structures, and Components

This section addresses the extraction steam lines for both pressurized water reactors (PWRs) and boiling water reactors (BWRs), which extend from the steam turbine to the feedwater heaters, including the drain lines. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the extraction steam system are governed by Group D Quality Standards.

The internals of the valves perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the extraction steam system include the steam turbine system (VIII.A), the PWR and BWR feedwater system (VIII.D1 and VIII.D2), and the condensate system (VIII.E).

VIII C	STEAM AND POWER CONVERSION SYSTEM Extraction Steam System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.C.SP-87	VIII.C-1(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.C.SP-88	VIII.C-2(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.C.SP-71	VIII.C-3(S-04)	Piping, piping components, and piping elements	Steel	Steam	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.C.S-15	VIII.C-5(S-15)	Piping, piping components, and piping elements	Steel	Steam	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
VIII.C.SP-73	VIII.C-6(S-09)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.C.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.C.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

D1. FEEDWATER SYSTEM (PWR)

Systems, Structures, and Components

This section addresses the main feedwater system for pressurized water reactors (PWRs), which extends from the condensate system to the steam generator. It consists of the main feedwater lines, feedwater pumps, and valves, including the containment isolation valves. Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” the portion of the feedwater system extending from the secondary side of the steam generator up to the second containment isolation valve is governed by Group B or C Quality Standards. All other components in the feedwater system located downstream from these isolation valves are governed by Group D Quality Standards.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems and structures that interface with the feedwater system include PWR concrete or steel containment structures (II.A1 and II.A2) and common components (II.A3), the steam generators (IV.D1 and IV.D2), the main steam system (VIII.B1), the extraction steam system (VIII.C), the condensate system (VIII.E), and the auxiliary feedwater system (VIII.G).

VIII STEAM AND POWER CONVERSION SYSTEM
D1 Feedwater Systems (PWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.D1.SP-90	VIII.D1-1(SP-24)	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.SP-92	VIII.D1-2(SP-32)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.SP-95	VIII.D1-3(SP-38)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.SP-87	VIII.D1-4(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.SP-88	VIII.D1-5(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.SP-91	VIII.D1-6(SP-25)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D1.S-11	VIII.D1-7(S-11)	Piping, piping components, and piping elements	Steel	Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 “Metal Fatigue,” for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA

VIII D1	STEAM AND POWER CONVERSION SYSTEM Feedwater Systems (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.D1.SP-74	VIII.D1-8(S-10)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.D1.S-16	VIII.D1-9(S-16)	Piping, piping components, and piping elements	Steel	Treated water	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
VIII.D1.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.D1.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

D2. FEEDWATER SYSTEM (BWR)

Systems, Structures, and Components

This section addresses the main feedwater system for boiling water reactors (BWRs), which extends from the condensate and condensate booster system to the outermost feedwater isolation valve on the feedwater lines to the reactor vessel. It consists of the main feedwater lines, feedwater pumps, and valves.

Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” the portions of the feedwater system extending from the outermost containment isolation valves up to and including the shutoff valve, or the first valve that is either normally closed or capable of closure during all modes of normal reactor operation, are governed by Group B Quality Standards. The remaining portions of the feedwater system consist of components governed by Group D Quality Standards. The portion of the feedwater system extending from the reactor vessel up to the second containment isolation valve, including the isolation valves, is governed by Group A Quality Standards and is covered in IV.C1.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the feedwater system include the BWR Mark 1, Mark 2, or Mark 3 containment structures (II.B1, II.B2, and II.B3, respectively) and common components (II.B4), the reactor coolant pressure boundary (IV.C1), the main steam system (VIII.B2), the extraction steam system (VIII.C), and the condensate system (VIII.E).

VIII STEAM AND POWER CONVERSION SYSTEM
D2 Feedwater Systems (BWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.D2.SP-90	VIII.D2-1(SP-24)	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.D2.SP-92	VIII.D2-2(SP-32)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D2.SP-95	VIII.D2-3(SP-38)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D2.SP-87	VIII.D2-4(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.D2.SP-91	VIII.D2-5(SP-25)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.D2.S-11	VIII.D2-6(S-11)	Piping, piping components, and piping elements	Steel	Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 “Metal Fatigue,” for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
VIII.D2.SP-73	VIII.D2-7(S-09)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

VIII D2	STEAM AND POWER CONVERSION SYSTEM Feedwater Systems (BWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.D2.S-16	VIII.D2-8(S-16)	Piping, piping components, and piping elements	Steel	Treated water	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
VIII.D2.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.D2.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

E. CONDENSATE SYSTEM

Systems, Structures, and Components

This section addresses the condensate system for both pressurized water reactors (PWRs) and boiling water reactors (BWRs), which extend from the condenser hotwells to the suction of feedwater pumps, including condensate and condensate booster pumps, condensate coolers, condensate cleanup system, and condensate storage tanks. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all components that comprise the condensate system are governed by Group D Quality Standards.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the condensate system include the steam turbine system (VIII.A), the PWR and BWR main steam system (VIII.B1 and VIII.B2), the PWR and BWR feedwater system (VIII.D1 and VIII.D2), the auxiliary feedwater system (VIII.G, PWR only), the BWR reactor water cleanup system (VII.E3), the open or closed cycle cooling water systems (VII.C1 or VII.C2), and the condensate storage facility.

VIII E	STEAM AND POWER CONVERSION SYSTEM Condensate System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.S-25	VIII.E-2(S-25)	Heat exchanger components	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-117	VIII.E-3(S-26)	Heat exchanger components	Stainless steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.S-23	VIII.E-5(S-23)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-146	VIII.E-6(S-24)	Heat exchanger components	Steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.SP-77	VIII.E-7(S-18)	Heat exchanger components	Steel	Treated water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-80	VIII.E-4(S-21)	Heat exchanger components and tubes	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-57	VIII.E-8(SP-57)	Heat exchanger tubes	Copper alloy	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No

VIII E	STEAM AND POWER CONVERSION SYSTEM Condensate System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.SP-56	VIII.E-9(SP-56)	Heat exchanger tubes	Copper alloy	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.SP-100	VIII.E-10(SP-58)	Heat exchanger tubes	Copper alloy	Treated water	Reduction of heat transfer due to fouling	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-41	VIII.E-11(SP-41)	Heat exchanger tubes	Stainless steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.S-28	VIII.E-12(S-28)	Heat exchanger tubes	Stainless steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.SP-96	VIII.E-13(SP-40)	Heat exchanger tubes	Stainless steel	Treated water	Reduction of heat transfer due to fouling	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-64	VIII.E-14(SP-64)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-90	VIII.E-15(SP-24)	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-8	VIII.E-16(SP-8)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-92	VIII.E-17(SP-32)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VIII STEAM AND POWER CONVERSION SYSTEM
E Condensate System

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.E.SP-31	VIII.E-18(SP-31)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.SP-29	VIII.E-19(SP-29)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.E.SP-30	VIII.E-20(SP-30)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.E.SP-55	VIII.E-21(SP-55)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.E.SP-26	VIII.E-22(SP-26)	Piping, piping components, and piping elements	Gray cast iron	Soil	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.E.SP-27	VIII.E-23(SP-27)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.E.SP-39	VIII.E-24(SP-39)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-54	VIII.E-25(SP-54)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.E.SP-95	VIII.E-26(SP-38)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VIII E	STEAM AND POWER CONVERSION SYSTEM Condensate System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.SP-36	VIII.E-27(SP-36)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.E.SP-94	VIII.E-28(SP-37)	Piping, piping components, and piping elements	Stainless steel	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.E.SP-87	VIII.E-29(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-88	VIII.E-30(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-91	VIII.E-32(SP-25)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-73	VIII.E-33(S-09)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.S-16	VIII.E-35(S-16)	Piping, piping components, and piping elements	Steel	Treated water	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No
VIII.E.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

VIII E	STEAM AND POWER CONVERSION SYSTEM Condensate System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.E.SP-145	VIII.E-1(S-01)	Piping, piping components, and piping elements; tanks	Steel (with coating or wrapping)	Soil or concrete	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.E.SP-81	VIII.E-36(S-22)	PWR heat exchanger components	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-78	VIII.E-37(S-19)	PWR heat exchanger components	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.SP-140		Tanks	Aluminum	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-139		Tanks	Aluminum	Soil or Concrete	Loss of material due to pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-138		Tanks	Stainless steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-137		Tanks	Stainless steel	Soil or Concrete	Loss of material due to pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No

VIII	STEAM AND POWER CONVERSION SYSTEM						
E	Condensate System						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.E.SP-97	VIII.E-38(SP-42)	Tanks	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.E.S-31	VIII.E-39(S-31)	Tanks	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-115		Tanks	Steel	Soil or Concrete	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.E.SP-75	VIII.E-40(S-13)	Tanks	Steel; stainless steel	Treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

F. STEAM GENERATOR BLOWDOWN SYSTEM (PWR)

Systems, Structures, and Components

This section addresses the steam generator blowdown system for pressurized water reactors (PWRs), which extends from the steam generator through the blowdown condenser and includes the containment isolation valves and small bore piping less than nominal pipe size (NPS) 2 in. (including instrumentation lines).

Based on Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” the portion of the blowdown system extending from the steam generator up to the isolation valve outside the containment and including the isolation valves is governed by Group B or C Quality Standards. The remaining portions of the steam generator blowdown system consist of components governed by Group D Quality Standards.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the blowdown system include the steam generator (IV.D1 and IV.D2) and the open- or closed-cycle cooling water systems (VII.C1 or VII.C2).

VIII	STEAM AND POWER CONVERSION SYSTEM						
F	Steam Generator Blowdown System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.F.SP-56	VIII.F-6(SP-56)	Heat exchanger components	Copper alloy	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.S-25	VIII.F-1(S-25)	Heat exchanger components	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-117	VIII.F-2(S-26)	Heat exchanger components	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.SP-85	VIII.F-3(S-39)	Heat exchanger components	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.S-23	VIII.F-4(S-23)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-146	VIII.F-5(S-24)	Heat exchanger components	Steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.SP-100	VIII.F-7(SP-58)	Heat exchanger tubes	Copper alloy	Treated water	Reduction of heat transfer due to fouling	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

VIII STEAM AND POWER CONVERSION SYSTEM
F Steam Generator Blowdown System (PWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.F.SP-41	VIII.F-8(SP-41)	Heat exchanger tubes	Stainless steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.S-28	VIII.F-9(S-28)	Heat exchanger tubes	Stainless steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.SP-96	VIII.F-10(SP-40)	Heat exchanger tubes	Stainless steel	Treated water	Reduction of heat transfer due to fouling	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.SP-64	VIII.F-11(SP-64)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-90	VIII.F-12(SP-24)	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.SP-8	VIII.F-13(SP-8)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-31	VIII.F-14(SP-31)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.SP-101	VIII.F-15(SP-61)	Piping, piping components, and piping elements	Copper alloy	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

VIII F	STEAM AND POWER CONVERSION SYSTEM Steam Generator Blowdown System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.F.SP-29	VIII.F-16(SP-29)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VIII.F.SP-30	VIII.F-17(SP-30)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VIII.F.SP-55	VIII.F-18(SP-55)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VIII.F.SP-27	VIII.F-19(SP-27)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, "Selective Leaching"	No
VIII.F.SP-39	VIII.F-20(SP-39)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-54	VIII.F-21(SP-54)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.F.SP-36	VIII.F-22(SP-36)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.F.SP-87	VIII.F-23(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No

VIII F	STEAM AND POWER CONVERSION SYSTEM Steam Generator Blowdown System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.F.SP-88	VIII.F-24(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.SP-74	VIII.F-25(S-10)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.S-16	VIII.F-26(S-16)	Piping, piping components, and piping elements	Steel	Treated water	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No
VIII.F.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.F.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.F.SP-81	VIII.F-27(S-22)	PWR heat exchanger components	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.F.SP-78	VIII.F-28(S-19)	PWR heat exchanger components	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

G. AUXILIARY FEEDWATER SYSTEM (PWR)

Systems, Structures, and Components

This section addresses the auxiliary feedwater (AFW) system for pressurized water reactors (PWRs), which extends from the condensate storage or backup water supply system to the steam generator or to the main feedwater (MFW) line. They consist of AFW piping, AFW pumps, pump turbine oil coolers, and valves, including the containment isolation valves.

Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," portions of the AFW system extending from the secondary side of the steam generator up to the second isolation valve and including the containment isolation valves are governed by Group B Quality Standards. In addition, portions of the AFW system that are required for their safety functions and that either do not operate during any mode of normal reactor operation or cannot be tested adequately are also governed by Group B Quality Standards. The remainder of the structures and components covered in this section are governed by Group C Quality Standards.

Pump and valve internals perform their intended functions with moving parts or with a change in configuration. They are subject to replacement based on qualified life or a specified time period. Pursuant to 10 CFR 54.21(a)(1), therefore, they are not subject to an aging management review.

Aging management programs for the degradation of the external surfaces of components and miscellaneous bolting are included in VIII.H. Common miscellaneous material/environment combinations, where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation, are included in VIII.I.

The system piping includes all pipe sizes, including instrument piping.

System Interfaces

The systems that interface with the AFW system include the steam generator (IV.D1 and IV.D2), the main steam system (VIII.B1), the PWR feedwater system (VIII.D1), the condensate system (VIII.E), and the open- or closed-cycle cooling water systems (VII.C1 or VII.C2).

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.S-25	VIII.G-2(S-25)	Heat exchanger components	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-79	VIII.G-3(S-20)	Heat exchanger components	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-117	VIII.G-4(S-26)	Heat exchanger components	Stainless steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.S-23	VIII.G-5(S-23)	Heat exchanger components	Steel	Closed-cycle cooling water	Loss of material due to general, pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-76	VIII.G-6(S-17)	Heat exchanger components	Steel	Lubricating oil	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.SP-146	VIII.G-7(S-24)	Heat exchanger components	Steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-113		Heat exchanger components and tubes	Aluminum	Lubricating oil	Reduction of heat transfer due to fouling	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-99	VIII.G-8(SP-53)	Heat exchanger tubes	Copper alloy	Lubricating oil	Reduction of heat transfer due to fouling	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-56	VIII.G-9(SP-56)	Heat exchanger tubes	Copper alloy	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-100	VIII.G-10(SP-58)	Heat exchanger tubes	Copper alloy	Treated water	Reduction of heat transfer due to fouling	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-41	VIII.G-11(SP-41)	Heat exchanger tubes	Stainless steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-102	VIII.G-12(SP-62)	Heat exchanger tubes	Stainless steel	Lubricating oil	Reduction of heat transfer due to fouling	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.S-28	VIII.G-13(S-28)	Heat exchanger tubes	Stainless steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-64	VIII.G-14(SP-64)	Heat exchanger tubes	Steel	Closed-cycle cooling water	Reduction of heat transfer due to fouling	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-103	VIII.G-15(SP-63)	Heat exchanger tubes	Steel	Lubricating oil	Reduction of heat transfer due to fouling	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.S-27	VIII.G-16(S-27)	Heat exchanger tubes	Steel	Raw water	Reduction of heat transfer due to fouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-114		Piping, piping components, and piping elements	Aluminum	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-90	VIII.G-17(SP-24)	Piping, piping components, and piping elements	Aluminum	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-8	VIII.G-18(SP-8)	Piping, piping components, and piping elements	Copper alloy	Closed-cycle cooling water	Loss of material due to pitting, crevice, and galvanic corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-92	VIII.G-19(SP-32)	Piping, piping components, and piping elements	Copper alloy	Lubricating oil	Loss of material due to pitting and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.SP-31	VIII.G-20(SP-31)	Piping, piping components, and piping elements	Copper alloy	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-29	VIII.G-21(SP-29)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Closed-cycle cooling water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-30	VIII.G-22(SP-30)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-55	VIII.G-23(SP-55)	Piping, piping components, and piping elements	Copper alloy (>15% Zn or >8% Al)	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-28	VIII.G-24(SP-28)	Piping, piping components, and piping elements	Gray cast iron	Raw water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-26	VIII.G-25(SP-26)	Piping, piping components, and piping elements	Gray cast iron	Soil	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-27	VIII.G-26(SP-27)	Piping, piping components, and piping elements	Gray cast iron	Treated water	Loss of material due to selective leaching	Chapter XI.M33, “Selective Leaching”	No
VIII.G.SP-39	VIII.G-27(SP-39)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water	Loss of material due to pitting and crevice corrosion	Chapter XI.M21A, "Closed Treated Water Systems"	No

VIII G	STEAM AND POWER CONVERSION SYSTEM Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.SP-54	VIII.G-28(SP-54)	Piping, piping components, and piping elements	Stainless steel	Closed-cycle cooling water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M21A, "Closed Treated Water Systems"	No
VIII.G.SP-95	VIII.G-29(SP-38)	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-36	VIII.G-30(SP-36)	Piping, piping components, and piping elements	Stainless steel	Raw water	Loss of material due to pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
VIII.G.SP-94	VIII.G-31(SP-37)	Piping, piping components, and piping elements	Stainless steel	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.G.SP-87	VIII.G-32(SP-16)	Piping, piping components, and piping elements	Stainless steel	Treated water	Loss of material due to pitting and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-88	VIII.G-33(SP-17)	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking due to stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No
VIII.G.SP-60	VIII.G-34(SP-60)	Piping, piping components, and piping elements	Steel	Condensation (Internal)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No

VIII	STEAM AND POWER CONVERSION SYSTEM						
G	Auxiliary Feedwater System (PWR)						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.G.SP-91	VIII.G-35(SP-25)	Piping, piping components, and piping elements	Steel	Lubricating oil	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M39, "Lubricating Oil Analysis," and Chapter XI.M32, "One-Time Inspection"	No
VIII.G.S-11	VIII.G-37(S-11)	Piping, piping components, and piping elements	Steel	Treated water	Cumulative fatigue damage due to fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the SRP, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
VIII.G.SP-74	VIII.G-38(S-10)	Piping, piping components, and piping elements	Steel	Treated water	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," and Chapter XI.M32, "One-Time Inspection"	No
VIII.G.S-16	VIII.G-39(S-16)	Piping, piping components, and piping elements	Steel	Treated water	Wall thinning due to flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
VIII.G.SP-118		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Cracking due to stress corrosion cracking	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated
VIII.G.SP-127		Piping, piping components, and piping elements; tanks	Stainless steel	Air – outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	Yes, environmental conditions need to be evaluated

VIII STEAM AND POWER CONVERSION SYSTEM
G Auxiliary Feedwater System (PWR)

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.G.SP-145	VIII.G-1(S-01)	Piping, piping components, and piping elements; tanks	Steel (with coating or wrapping)	Soil or concrete	Loss of material due to general, pitting, crevice, and microbiologically-influenced corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.G.SP-136	VIII.G-36(S-12)	Steel Piping, piping components, and piping elements exposed to Raw water	Steel	Raw water	Loss of material due to general, pitting, crevice, galvanic, and microbiologically-influenced corrosion; fouling that leads to corrosion	Chapter XI.M38, "Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components"	No
VIII.G.S-31	VIII.G-40(S-31)	Tanks	Steel	Air – outdoor (External)	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.G.SP-116		Tanks	Steel	Soil or Concrete	Loss of material due to general, pitting, and crevice corrosion	Chapter XI.M29, “Aboveground Metallic Tanks”	No
VIII.G.SP-75	VIII.G-41(S-13)	Tanks	Steel; stainless steel	Treated water	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M2, “Water Chemistry,” and Chapter XI.M32, “One-Time Inspection”	No

H. EXTERNAL SURFACES OF COMPONENTS AND MISCELLANEOUS BOLTING

Systems, Structures, and Components

This section includes the aging management programs for the degradation of external surfaces of all steel structures and components, including closure bolting in the steam and power conversion system in pressurized water reactors (PWRs) and boiling water reactors (BWRs). For the steel components in PWRs, this section addresses only boric acid corrosion of external surfaces as a result of dripping borated water leaking from an adjacent PWR component.

System Interfaces

The structures and components covered in this section belong to the Steam and Power Conversion Systems in PWRs and BWRs (for example, see system interfaces in VIII.A to VIII.G for details).

VIII H	STEAM AND POWER CONVERSION SYSTEM External Surfaces of Components and Miscellaneous Bolting						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.H.SP-149		Bolting	Copper alloy	Any environment	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.SP-150		Bolting	Nickel alloy	Any environment	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.SP-143		Bolting	Stainless steel	Soil or concrete	Loss of material due to pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.H.SP-144		Bolting	Stainless steel	Soil	Loss of preload	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.S-40	VIII.H-2(S-40)	Bolting	Steel	Air with borated water leakage	Loss of material due to boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
VIII.H.SP-141		Bolting	Steel	Soil or concrete	Loss of material due to general, pitting and crevice corrosion	Chapter XI.M41, "Buried and Underground Piping and Tanks"	No
VIII.H.SP-142		Bolting	Steel	Soil	Loss of preload	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.SP-82	VIII.H-1(S-32)	Bolting	Steel; stainless steel	Air – outdoor (External)	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M18, "Bolting Integrity"	No

VIII STEAM AND POWER CONVERSION SYSTEM
H External Surfaces of Components and Miscellaneous Bolting

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.H.SP-151		Bolting	Steel; stainless steel	Air – outdoor (External)	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.S-03	VIII.H-3(S-03)	Closure bolting	High-strength steel	Air with steam or water leakage	Cracking due to cyclic loading, stress corrosion cracking	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.S-02	VIII.H-6(S-02)	Closure bolting	Steel	Air with steam or water leakage	Loss of material due to general corrosion	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.SP-84	VIII.H-4(S-34)	Closure bolting	Steel; stainless steel	Air – indoor, uncontrolled (External)	Loss of material due to general (steel only), pitting, and crevice corrosion	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.SP-83	VIII.H-5(S-33)	Closure bolting	Steel; stainless steel	Air – indoor, uncontrolled (External)	Loss of preload due to thermal effects, gasket creep, and self-loosening	Chapter XI.M18, "Bolting Integrity"	No
VIII.H.S-29	VIII.H-7(S-29)	External surfaces	Steel	Air – indoor, uncontrolled (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.H.S-41	VIII.H-8(S-41)	External surfaces	Steel	Air – outdoor (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.H.S-30	VIII.H-9(S-30)	External surfaces	Steel	Air with borated water leakage	Loss of material due to boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No

VIII	STEAM AND POWER CONVERSION SYSTEM						
H	External Surfaces of Components and Miscellaneous Bolting						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.H.S-42	VIII.H-10(S-42)	External surfaces	Steel	Condensation (External)	Loss of material due to general corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.H.SP-147		Piping, piping components, and piping elements	Aluminum	Air - outdoor	Loss of material due to pitting and crevice corrosion	Chapter XI.M36, "External Surfaces Monitoring of Mechanical Components"	No
VIII.H.SP-161		Underground piping, piping components, and piping elements	Steel; stainless steel; copper alloy; aluminum	Air-indoor uncontrolled or condensation (External)	Loss of material due to general (steel only), pitting and crevice corrosion	Chapter XI.M41, “Buried and Underground Piping and Tanks”	No

I. COMMON MISCELLANEOUS MATERIAL/ENVIRONMENT COMBINATIONS

Systems, Structures, and Components

This section includes the aging management programs for miscellaneous material/environment combinations which may be found throughout the steam and power conversion system's structures and components. For the material/environment combinations in this part, aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation. Therefore, no resulting aging management programs for these structures and components are required.

System Interfaces

The structures and components covered in this section belong to the steam and power conversion system in pressurized water reactors (PWRs) and boiling water reactors (BWRs) (for example, see system interfaces in VIII.A to VIII.G2 for details).

VIII STEAM AND POWER CONVERSION SYSTEM
I Common Miscellaneous Material/Environment Combinations

Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
VIII.I.SP-33	VIII.I-4(SP-33)	Piping elements	Glass	Air	None	None	No
VIII.I.SP-9	VIII.I-5(SP-9)	Piping elements	Glass	Air – indoor, uncontrolled (External)	None	None	No
VIII.I.SP-108		Piping elements	Glass	Air – outdoor	None	None	No
VIII.I.SP-67		Piping elements	Glass	Air with borated water leakage	None	None	No
VIII.I.SP-70		Piping elements	Glass	Closed-cycle cooling water	None	None	No
VIII.I.SP-68		Piping elements	Glass	Condensation	None	None	No
VIII.I.SP-111		Piping elements	Glass	Condensation (Internal/External)	None	None	No
VIII.I.SP-69		Piping elements	Glass	Gas	None	None	No
VIII.I.SP-10	VIII.I-6(SP-10)	Piping elements	Glass	Lubricating oil	None	None	No

VIII I	STEAM AND POWER CONVERSION SYSTEM Common Miscellaneous Material/Environment Combinations						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.I.SP-34	VIII.I-7(SP-34)	Piping elements	Glass	Raw water	None	None	No
VIII.I.SP-35	VIII.I-8(SP-35)	Piping elements	Glass	Treated water	None	None	No
VIII.I.SP-93		Piping, piping components, and piping elements	Aluminum	Air – indoor, uncontrolled (Internal/External)	None	None	No
VIII.I.SP-23	VIII.I-1(SP-23)	Piping, piping components, and piping elements	Aluminum	Gas	None	None	No
VIII.I.SP-6	VIII.I-2(SP-6)	Piping, piping components, and piping elements	Copper alloy	Air – indoor, uncontrolled (External)	None	None	No
VIII.I.SP-5	VIII.I-3(SP-5)	Piping, piping components, and piping elements	Copper alloy	Gas	None	None	No
VIII.I.SP-104		Piping, piping components, and piping elements	Copper alloy (≤15% Zn and ≤8% Al)	Air with borated water leakage	None	None	No

VIII	STEAM AND POWER CONVERSION SYSTEM						
I	Common Miscellaneous Material/Environment Combinations						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.I.SP-11	VIII.I-9(SP-11)	Piping, piping components, and piping elements	Nickel alloy	Air – indoor, uncontrolled (External)	None	None	No
VIII.I.SP-148		Piping, piping components, and piping elements	Nickel alloy	Air with borated water leakage	None	None	No
VIII.I.SP-152		Piping, piping components, and piping elements	PVC	Air – indoor, uncontrolled	None	None	No
VIII.I.SP-153		Piping, piping components, and piping elements	PVC	Condensation (Internal)	None	None	No
VIII.I.SP-12	VIII.I-10(SP-12)	Piping, piping components, and piping elements	Stainless steel	Air – indoor, uncontrolled (External)	None	None	No
VIII.I.SP-86		Piping, piping components, and piping elements	Stainless steel	Air – indoor, uncontrolled (Internal)	None	None	No
VIII.I.SP-13	VIII.I-11(SP-13)	Piping, piping components, and piping elements	Stainless steel	Concrete	None	None	No

VIII I	STEAM AND POWER CONVERSION SYSTEM Common Miscellaneous Material/Environment Combinations						
Item	**Link**	**Structure and/or Component**	**Material**	**Environment**	**Aging Effect/ Mechanism**	**Aging Management Program (AMP)**	**Further Evaluation**
VIII.I.SP-15	VIII.I-12(SP-15)	Piping, piping components, and piping elements	Stainless steel	Gas	None	None	No
VIII.I.SP-1	VIII.I-13(SP-1)	Piping, piping components, and piping elements	Steel	Air – indoor controlled (External)	None	None	No
VIII.I.SP-154	VIII.I-14(SP-2)	Piping, piping components, and piping elements	Steel	Concrete	None	None, provided: 1) attributes of the concrete are consistent with ACI 318 or ACI 349 (low water-to-cement ratio, low permeability, and adequate air entrainment) as cited in NUREG-1557, and 2) plant OE indicates no degradation of the concrete	No, if conditions are met.
VIII.I.SP-4	VIII.I-15(SP-4)	Piping, piping components, and piping elements	Steel	Gas	None	None	No

CHAPTER IX

SELECTED DEFINITIONS AND USE OF TERMS FOR STRUCTURES, COMPONENTS, MATERIALS, ENVIRONMENTS, AGING EFFECTS, AND AGING MECHANISMS

SELECTED DEFINITIONS AND USE OF TERMS FOR DESCRIBING AND STANDARDIZING STRUCTURES, COMPONENTS, MATERIALS, ENVIRONMENTS, AGING EFFECTS, AND AGING MECHANISMS

A. Introduction

The format and content of the aging management review (AMR) tables presented here (GALL Report, Rev. 2), have been revised to enhance the report's applicability to future plant license renewal applications. Several types of changes are incorporated in this revision to achieve the objective. One of these changes is to incorporate additional material, environment, aging effect and program (MEAP) combinations established by precedents based on a strong technical justification from earlier license renewal applications (LRAs) and the corresponding NRC safety evaluation reports (SERs).

The NRC has added several new definitions and clarified some of those that were in the GALL Report , Rev.1.

B. Structures and Components

The GALL Report does not address scoping of structures and components for license renewal. Scoping is plant-specific, and the results depend on individual plant design and its current licensing basis. The inclusion of a certain structure or component in the GALL Report does not mean that this particular structure or component is within the scope of license renewal for all plants. Conversely, the omission of a certain structure or component in the GALL Report does not mean that this particular structure or component is omitted from the scope of license renewal for any plant.

IX.B Selected Definitions & Use of Terms for Describing and Standardizing STRUCTURES AND COMPONENTS

Term	Definition as used in this document
Bolting	Bolting can refer to structural bolting, closure bolting, or all other bolting. Within the scope of license renewal, both Class 1 and non-Class 1 systems and components contain bolted closures that are necessary for the pressure boundary of the components being joined or closed. Closure bolting in high-pressure or high-temperature systems is defined as that in which the pressure exceeds 275 psi or 200°F (93°C). Closure bolting is used to join pressure boundaries or where a mechanical seal is required.
Ducting and components	Ducting and components include heating, ventilation, and air-conditioning (HVAC) components. Examples include ductwork, ductwork fittings, access doors, equipment frames and housing, housing supports, including housings for valves, dampers (including louvers, gravity, and fire dampers), and ventilation fans (including exhaust fans, intake fans, and purge fans). In some cases, this includes HVAC closure bolts or HVAC piping.
Encapsulation components/ valve chambers	These are airtight enclosures that function as a secondary containment boundary to completely enclose containment sump lines and isolation valves. Encapsulation components and features (e.g., emergency core cooling system, containment spray system, and containment isolation system, and refueling water storage tank, etc.) can include encapsulation vessels, piping, and valves.
"Existing programs" components	Per EPRI MRP-227 [Ref. 1] guidance on inspection and evaluation, PWR vessel internals (GALL AMP XI.M16A) were assigned to one of the following four groups: Primary, Expansion, Existing Programs, and No Additional Measures. Existing program components are those PWR internals that are susceptible to the effects of at least one of the aging mechanisms identified in MRP-227 and for which generic and plant-specific existing AMP elements are capable of managing those effects.
"Expansion" components	Per EPRI MRP-227 guidance on inspection and evaluation, PWR vessel internals (GALL AMP XI.M16A) were assigned to one of the following four

IX.B Selected Definitions & Use of Terms for Describing and Standardizing STRUCTURES AND COMPONENTS

Term	Definition as used in this document
	groups: Primary, Expansion, Existing Programs, and No Additional Measures. "Expansion" components are those PWR internals that are highly or moderately susceptible to the effects of at least one of the aging mechanisms addressed by MRP-227, but for which functionality assessment has shown a degree of tolerance to those effects. (See MRP-227, Section 3.3)
External surfaces	In the context of structures and components, the term "external surfaces" is used to represent the external surfaces of structures and components, such as tanks, that are not specifically listed elsewhere.
Heat exchanger components	A heat exchanger is a device that transfers heat from one fluid to another without the fluids coming in contact with each other. This includes air handling units and other devices that cool or heat fluids. Heat exchanger components may include, but are not limited to, air handling unit cooling and heating coils, piping/tubing, shell, tubesheets, tubes, valves, and bolting. Although tubes are the primary heat transfer components, heat exchanger internals, including tubesheets and fins, contribute to heat transfer and may be affected by reduction of heat transfer due to fouling [Ref. 2]. The inclusion of components such as tubesheets is dependent on manufacturer specifications.
High voltage insulators	An insulator is an insulating material in a configuration designed to physically support a conductor and separate the conductor electrically from other conductors or objects. The high voltage insulators that are evaluated for license renewal are those used to support and insulate high voltage electrical components in switchyards, switching stations and transmission lines.
Metal enclosed bus	"Metal enclosed bus" (MEB) is the term used in electrical and industry standards (IEEE and ANSI) for electrical buses installed on electrically-insulated supports constructed with all phase conductors enclosed in a metal enclosure.

IX.B Selected Definitions & Use of Terms for Describing and Standardizing STRUCTURES AND COMPONENTS

Term	Definition as used in this document
"No Additional Measures" components	Per EPRI MRP-227 guidance on inspection and evaluation, PWR vessel internals (GALL AMP XI.M16A) were assigned to one of the following four groups: Primary, Expansion, Existing Programs, and No Additional Measures. Additional components were placed in the "No Additional Measures," group as a result of the Failure Mode, Effects, and Criticality Analysis and the functionality assessment. Note: Components with no additional measures are not uniquely identified in GALL tables (see AMR Items IV.B2.RP-265, IV.B2.RP-267, IV.B3.RP-306, IV.B3.RP-307, IV.B4.RP-236, and IV.B4.RP-237. Components with no additional measures are defined in Section 3.3.1 of MRP-227, "Materials Reliability Program: Pressurized Water Reactor Internals Inspection and Evaluation Guidelines."
Piping, piping components, piping elements, and tanks	This general category includes features of the piping system within the scope of license renewal. Examples include piping, fittings, tubing, flow elements/indicators, demineralizers, nozzles, orifices, flex hoses, pump casings and bowls, safe ends, sight glasses, spray heads, strainers, thermowells, and valve bodies and bonnets. For reactor coolant pressure boundary components in Chapter IV that are subject to cumulative fatigue damage, this category also can include flanges, nozzles and safe ends, penetrations, instrument connections, vessel heads, shells, welds, weld inlays and weld overlays, stub tubes, and miscellaneous Class 1 components (e.g., pressure housings, etc.). As used in AMP XI.M41, buried piping and tanks are in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks are below grade, but are contained within a tunnel or vault such that they are in contact with air and are located where access for inspection is restricted.

IX.B Selected Definitions & Use of Terms for Describing and Standardizing STRUCTURES AND COMPONENTS

Term	Definition as used in this document
Piping elements	The category of “piping elements” is a sub-category of piping, piping components, and piping elements that in GALL Report, Rev. 2 applies only to components made of glass (e.g., sight glasses and level indicators, etc.). In the GALL Report, Chapters V, VII, and VIII, piping elements are thus called out separately.
Pressure housing	The term “pressure housing” only refers to pressure housing for the control rod drive (CRD) head penetration (it is only of concern in Section A2 for PWR reactor vessels).
“Primary” components	Per EPRI MRP-227 guidance on inspection and evaluation, PWR vessel internals (GALL AMP XI.M16A) were assigned to one of the following four groups: Primary, Expansion, Existing Programs, and No Additional Measures. Primary components are those PWR internals that are highly susceptible to the effects of at least one of the aging mechanisms addressed by MRP-227. The Primary group also includes components which have shown a degree of tolerance to a specific aging degradation effect, but for which no highly susceptible component exists or for which no highly susceptible component is accessible.
Reactor coolant pressure boundary components	Reactor coolant pressure boundary components include, but are not limited to, piping, piping components, piping elements, flanges, nozzles, safe ends, pressurizer vessel shell heads and welds, heater sheaths and sleeves, penetrations, and thermal sleeves.
Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	This category includes elastomer components used as sealants or gaskets.
Steel elements: liner; liner anchors; integral attachments	This category includes steel liners used in suppression pools or spent fuel pools.
Switchyard bus	Switchyard bus is the uninsulated, unenclosed, rigid electrical conductor or pipe used in switchyards and switching stations to connect two or more elements of an electrical power circuit, such as active disconnect switches and passive transmission conductors.

IX.B Selected Definitions & Use of Terms for Describing and Standardizing STRUCTURES AND COMPONENTS

Term	Definition as used in this document
Tanks	Tanks are large reservoirs used as hold-up volumes for liquids or gases. Tanks may have an internal liquid and/or vapor space and may be partially buried or in close proximity to soils or concrete. Tanks are treated separately from piping due to their potential need for different aging management programs (AMP). One example is GALL AMP XI.M29, “Aboveground Metallic Tanks,” for tanks partially buried or in contact with soil or concrete that experience general corrosion as the aging effect at the soil or concrete interface.
Transmission conductors	Transmission conductors are uninsulated, stranded electrical cables used in switchyards, switching stations, and transmission lines to connect two or more elements of an electrical power circuit, such as active disconnect switches, power circuit breakers, and transformers and passive switchyard bus.
Vibration isolation elements	This category includes non-steel supports used for supporting components prone to vibration.

C. Materials

The following table defines many generalized materials used in the preceding GALL AMR tables in Chapters II through VIII of GALL Report, Rev. 2.

IX.C Selected Definitions & Use of Terms for Describing and Standardizing MATERIALS

Term	Definition as used in this document
Boraflex	Boraflex is a material that is composed of 46% silica, 4% polydimethyl siloxane polymer, and 50% boron carbide, by weight. It is a neutron-absorbing material used in spent fuel storage racks. Degradation of Boraflex panels under gamma radiation can lead to a loss of their ability to absorb neutrons in spent fuel storage pools. The aging management program for Boraflex is found in GALL AMP XI.M22, "Boraflex Monitoring."
Boral®, boron steel	Boron steel is steel with a boron content ranging from one to several percent. Boron steel absorbs neutrons and is often used as a control rod to help control the neutron flux. Boral® is a cermet consisting of a core of aluminum and boron carbide powder sandwiched between sheets of aluminum. Boral refers to patented Aluminum-Boron master alloys; these alloys can contain up to 10% boron as AlB_{12} intermetallics.
Cast austenitic stainless steel (CASS)	CASS alloys, such as CF-3, CF-8, CF-3M, and CF-8M, have been widely used in LWRs. These CASS alloys are similar to wrought grades Type 304L, Type 304, Type 316L, and Type 316, except CASS typically contains 5 to 25% ferrite. CASS is susceptible to loss of fracture toughness due to thermal and neutron irradiation embrittlement.
Concrete and cementitious material	When used generally, this category of concrete applies to concrete in many different configurations (block, cylindrical, etc.) and prestressed or reinforced concrete. Cementitious material can be defined as any material having cementing properties, which contributes to the formation of hydrated calcium silicate compounds. When mixing concrete, the following have cementitious properties: Portland cement, blended hydraulic cement, fly ash, ground granulated blast furnace slag, silica fume, calcined clay, metakaolin, calcined shale, and rice husk ash. This category may include asbestos cement.

IX.C Selected Definitions & Use of Terms for Describing and Standardizing MATERIALS

Term	Definition as used in this document
Copper alloy (≤15% Zn and ≤8% Al)	This category applies to those copper alloys whose critical alloying elements are less than the thresholds that keep the alloy from being susceptible to aging effects. For example, copper, copper nickel, brass, bronze ≤15% zinc (Zn), and aluminum bronze ≤8% aluminum (Al) are resistant to stress corrosion cracking, selective leaching, and pitting and crevice corrosion. They may be identified simply as "copper alloy" when these aging mechanisms are not at issue.
Copper alloy (>15% Zn or >8% Al)	This category applies to those copper alloys whose critical alloying elements are above the thresholds that make them susceptible to aging effects. Copper-zinc alloys >15% zinc are susceptible to stress corrosion cracking (SCC), selective leaching (except for inhibited brass), and pitting and crevice corrosion. Additional copper alloys, such as aluminum bronze > 8% aluminum, also may be susceptible to SCC or leaching. The elements that are most commonly alloyed with copper are zinc (forming brass), tin (forming bronze), nickel, silicon, aluminum (forming aluminum-bronze), cadmium, and beryllium. Additional copper alloys may be susceptible to these aging effects if they fall above the threshold for the critical alloying element. [Ref. 3]
Elastomers	Elastomers are flexible materials such as rubber, EPT, EPDM, PTFE, ETFE, viton, vitril, neoprene, and silicone elastomer. Hardening and loss of strength of elastomers can be induced by elevated temperature (over about 95°F or 35°C), and additional aging factors (e.g., exposure to ozone, oxidation, and radiation, etc.). [Ref. 4]
Galvanized steel	Galvanized steel is steel coated with zinc, usually by immersion or electrodeposition. The zinc coating protects the underlying steel because the corrosion rate of the zinc coating in dry, clean air is very low. In the presence of moisture, galvanized steel is classified under the category "Steel."
Glass	This category includes any glass material. Glass is a hard, amorphous, brittle, super-cooled liquid made by fusing together one or more of the oxides of silicon, boron, or phosphorous with certain basic oxides (e.g., Na, Mg, Ca, K), and cooling the product rapidly to prevent crystallization or devitrification.
Graphitic tool steel	Graphitic tool steels (such as AISI O6, which is oil-hardened, and, AISI A10, which is air-hardened), have excellent non-seizing properties. The graphite particles provide self-lubricity and hold applied lubricants.

IX.C Selected Definitions & Use of Terms for Describing and Standardizing MATERIALS

Term	Definition as used in this document
Gray cast iron	Gray cast iron is an iron alloy made by adding larger amounts of carbon to molten iron than would be used to make steel. Most steel has less than about 1.2% by weight carbon, while cast irons typically have between 2.5 to 4%. Gray cast iron contains flat graphite flakes that reduce its strength and form cracks, inducing mechanical failures. They also cause the metal to behave in a nearly brittle fashion, rather than experiencing the elastic, ductile behavior of steel. Fractures in this type of metal tend to take place along the flakes, which give the fracture surface a gray color, hence the name of the metal. Gray cast iron is susceptible to selective leaching, resulting in a significant reduction of the material's strength due to the loss of iron from the microstructure, leaving a porous matrix of graphite. In some environments, gray cast iron is categorized with the group "Steel."
Insulation materials (e.g., bakelite, phenolic melamine or ceramic, molded polycarbonate)	Insulation materials in this category are bakelite, phenolic melamine or ceramic, molded polycarbonate, etc. used in electrical fuse holders.
Low-alloy steel, yield strength >150 ksi	Low-alloy steel includes AISI steels 4140, 4142, 4145, 4140H, 4142H, and 4145H (UNS#: G41400, G41420, G41450, H41400, H41420, H41450). Low-alloy steel bolting material, SA 193 Gr. B7, is a ferritic, low-alloy steel for high-temperature service. High-strength low-alloy (Fe-Cr-Ni-Mo) steel bolting materials have a maximum tensile strength of <1172 MPa (<170 ksi). They may be subject to stress corrosion cracking if the actual measured yield strength, S_y, ≥ 150 ksi (1034 MPa). Bolting fabricated from high-strength (actual measured yield strength, S_y, ≥ 150 ksi or 1034 MPa) low-alloy steel, SA 193 Gr. B7, is susceptible to stress corrosion cracking. Examples of high-strength alloy steels that comprise this category include SA540-Gr. B23/24, SA193-Gr. B8, and Grade L43 (AISI4340).
Lubrite®	Lubrite® refers to a patented technology in which the bearing substrate (bronze is commonly used, but in unusual environments can range from stainless steel and nodular-iron to tool-steel) is fastened to lubricant. Lubrite® is often defined as bronze attached to ASTM B22, alloy 905, with G10 lubricant. Even though Lubrite® bearings are characterized as maintenance-free because of the differences in installation,

IX.C Selected Definitions & Use of Terms for Describing and Standardizing MATERIALS

Term	Definition as used in this document
	fineness of the surfaces, and lubricant characteristics, they can experience mechanical wear and fretting. Bearings generally have not shown adverse conditions related to the use of Lubrite®. The unique environment and precise installation tolerances required for installing the bearings require bearing-specific examinations. The vendor's (Lubrite® Technologies) literature shows ten lubricant types used in the bearings, ranging from G1 (General Duty) to AE7 (temperature- and radiation-tested) lubricants. The type of lubricant used depends on the plant-specific requirements. Careful installation and clearing out any obstructions during installation ensures that the required tolerances of the bearings are met and reduces the likelihood of functional problems during challenging loading conditions (such as design basis accident [DBA] or safe shutdown earthquake [SSE]). The associated aging effects could include malfunctioning, distortion, dirt accumulation, and fatigue under vibratory and cyclic thermal loads. The potential aging effects could be managed by incorporating its periodic examination in ASME Section XI, Subsection IWF (AMP XI.S3) or in Structures Monitoring (AMP XI.S6).
Malleable iron	The term "Malleable iron" usually means malleable cast iron, characterized by exhibiting some elongation and reduction in area in a tensile test. Malleable iron is one of the materials in the category of "Porcelain, Malleable iron, aluminum, galvanized steel, cement."
Nickel alloys	Nickel alloys are nickel-chromium-iron (molybdenum) alloys and include the Alloys 600 and 690. Examples of nickel alloys include Alloy 182, 600, and 690, Gr. 688 (X-750), Inconel 182, Inconel 82, NiCrFe, SB-166, -167, and -168, and X-750. [Ref. 5]
Polymer	This category generally includes flexible polymeric materials (such as rubber) and rigid polymers (like PVC). As used in GALL Report, Rev. 2 AMR Items VI.A.LP-33, VI.A.LP-34, and VI.A.LP-35, polymers used in electrical applications include EPR (ethylene-propylene rubber), SR (silicone rubber), EPDM (ethylene propylene diene monomer), and XLPE (crosslinked polyethylene). XLPE is a cross-linked polyethylene thermoplastic resin, such as polyethylene and polyethylene copolymers. EPR and EPDM are ethylene-propylene rubbers in the category of thermosetting elastomers.

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Term	Definition as used in this document
Porcelain	Hard-quality porcelain is used as an insulator for supporting high-voltage electrical insulators. Porcelain is a hard, fine-grained ceramic that consists of kaolin, quartz, and feldspar fired at high temperatures.
SA508-Cl 2 forgings clad with stainless steel using a high-heat-input welding process	This category consists of quenched and tempered vacuum-treated carbon and alloy steel forgings for pressure vessels.
Stainless steel	Products grouped under the term "stainless steel" include wrought or forged austenitic, ferritic, martensitic, precipitation-hardened (PH), or duplex stainless steel (Cr content >11%). These materials are susceptible to a variety of aging effects and mechanisms, including loss of material due to pitting and crevice corrosion, and cracking due to stress corrosion cracking. In some cases, when the recommended AMP is the same for PH stainless steel or cast austenitic stainless steel (CASS) as for stainless steel, PH stainless steel or CASS are included as a part of the stainless steel classification. However, CASS is quite susceptible to loss of fracture toughness due to thermal and neutron irradiation embrittlement. Therefore, when this aging effect is being considered, CASS is specifically designated in an AMR line-item. Steel with stainless steel cladding also may be considered stainless steel when the aging effect is associated with the stainless steel surface of the material, rather than the composite volume of the material. Examples of stainless steel designations that comprise this category include A-286, SA193-Gr. B8, SA193-Gr. B8M, Gr. 660 (A-286), SA193-6, SA193-Gr. B8 or B-8M, SA453, and Types 304, 304NG, 308, 308L, 309, 309L, 316, 347, 403, and 416. Examples of CASS designations include CF-3, -8, -3M, and -8M. [Ref. 6, 7]
Steel	In some environments, carbon steel, alloy steel, cast iron, gray cast iron, malleable iron, and high-strength low-alloy steel are vulnerable to general, pitting, and crevice corrosion, even though the rates of aging may vary. Consequently, these metal types are generally grouped under the broad term "steel." Note that this does not include stainless steel, which has its own category. However, gray cast iron also is susceptible to selective leaching, and high-strength low-alloy steel is susceptible to stress corrosion cracking. Therefore, when these aging effects are being considered, these

Term	Definition as used in this document
	materials are specifically identified. Galvanized steel (zinc-coated carbon steel) is also included in the category of "steel" when exposed to moisture. Malleable iron is specifically called out in the phrase "Porcelain, Malleable iron, aluminum, galvanized steel, cement," which is used to define the high voltage insulators in GALL Chapter VI. Examples of steel designations included in this category are ASTM A36, ASTM A285, ASTM A759, SA36, SA106-Gr. B, SA155-Gr. KCF70, SA193-Gr. B7, SA194 -Gr. 7, SA302-Gr B, SA320-Gr. L43 (AISI 4340), SA333-Gr. 6, SA336, SA508-64, class 2, SA508-Cl 2 or Cl 3, SA516-Gr. 70, SA533-Gr. B, SA540-Gr. B23/24, and SA582. [Ref. 6, 7]
Superaustenitic stainless steel	Superaustenitic stainless steels have the same structure as the common austenitic alloys, but they have enhanced levels of elements such as chromium, nickel, molybdenum, copper, and nitrogen, which give them superior strength and corrosion resistance. Compared to conventional austenitic stainless steels, superaustenitic materials have a superior resistance to pitting and crevice corrosion in environments containing halides. Several NPPs have installed superaustenitic stainless steel (AL-6XN) buried piping.
Titanium	The category titanium includes unalloyed titanium (ASTM grades 1-4) and various related alloys (ASTM grades 5, 7. 9, and 12). The corrosion resistance of titanium is a result of the formation of a continuous, stable, highly adherent protective oxide layer on the metal surface. Titanium and titanium alloys may be susceptible to crevice corrosion in saltwater environments at elevated temperatures (>160°F). Titanium Grades 5 and 12 are resistant to crevice corrosion in seawater at temperatures as high as 500°F. Stress corrosion cracking of titanium and its alloys is considered applicable in sea water or brackish raw water systems if the titanium alloy contains more than 5% aluminum or more than 0.20% oxygen or any amount of tin. ASTM Grades 1, 2, 7, 11, or 12 are not susceptible to stress corrosion cracking in seawater or brackish raw water [Ref. 8].
Wood	Wood piles or sheeting exposed to flowing or standing water is subject to loss of material or changes in material properties due to weathering, chemical degradation, insect infestation, repeated wetting and drying, or fungal decay.
Zircaloy-4	Zircaloy-4, (Zry-4), is a member in the group of high-zirconium (Zr) alloys. Such zircaloys are used in nuclear

IX.C Selected Definitions & Use of Terms for Describing and Standardizing MATERIALS

Term	Definition as used in this document
	technology, as Zr has very low absorption cross-section of thermal neutrons. In the GALL Report, Zry-4 is referenced in AMR Item IV.B3.RP-357 for incore instrumentation thimble tubes. Zry-4 consists of 98.23 weight % zirconium with 1.45% tin, 0.21% iron, 0.1% chromium, and 0.01% hafnium.

D. Environments

The following table defines many of the standardized environments used in the preceding GALL AMR tables in Chapters II through VIII of the GALL Report, Rev. 2.

The usage of temperature thresholds for describing aging effects are continued as in the GALL Report, Rev. 1.

Temperature threshold of 95°F (35°C) for thermal stresses in elastomers: In general, if the ambient temperature is less than about 95°F (35°C), then thermal aging may be considered not significant for rubber, butyl rubber, neoprene, nitrile rubber, silicone elastomer, fluoroelastomer, EPR, and EPDM [Ref. 3]. Hardening and loss of strength of elastomers can be induced by thermal aging, exposure to ozone, oxidation, and radiation. When applied to the elastomers used in electrical cable insulation, it should be noted that most cable insulation is manufactured as either 75°C (167°F) or 90°C (194°F) rated material.

Temperature threshold of 140°F (60°C) for SCC in stainless steel: Stress corrosion cracking (SCC) occurs very rarely in austenitic stainless steels below 140°F (60°C). Although SCC has been observed in stagnant, oxygenated borated water systems at lower temperatures than this 140°F threshold, all of these instances have identified a significant presence of contaminants (halogens, specifically chlorides) in the failed components. With a harsh enough environment (i.e., significant contamination), SCC can occur in austenitic stainless steel at ambient temperature. However, these conditions are considered event-driven, resulting from a breakdown of chemistry controls [Ref. 8, 9].

Temperature threshold of 482°F (250°C) for thermal embrittlement in CASS: CASS subjected to sustained temperatures below 250°C (482°F) will not result in a reduction of room temperature Charpy impact energy below 50 ft-lb for exposure times of approximately 300,000 hours (for CASS with ferrite content of 40% and approximately 2,500,000 hours for CASS with ferrite content of 14%) [Fig. 2; Ref. 10]. For a maximum exposure time of approximately 420,000 hours (48 EFPY), a screening temperature of 482°F is conservatively chosen because (1) the majority of nuclear grade materials is expected to contain a ferrite content well below 40%, and (2) the 50 ft-lb limit is very conservative when applied to cast austenitic materials. It is typically applied to ferritic materials, e.g., 10 CFR 50 Appendix G. For CASS components in the reactor coolant pressure boundary, this threshold is supported by the GALL AMP XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)," with the exception of niobium-containing steels, which require evaluation on a case-by-case basis.

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Adverse localized environment	An adverse localized environment is an environment limited to the immediate vicinity of a component that is hostile to the component material, thereby leading to potential aging effects. As used in GALL, the conductor insulation used for electrical cables in instrumentation circuits can be subjected to an adverse localized environment. As represented by a specific GALL AMR Item, an adverse localized environment can be due to any of the following: (1) exposure to significant moisture (LP-35), (2) heat, radiation, or moisture (L-01 or LP-34), or (3) heat, radiation, moisture, or voltage (L-05).
Aggressive environment (steel in concrete)	This environment affects steel embedded in concrete with a pH <5.5 or a chloride concentration >500 ppm or sulfate > 1500 ppm. [Ref. 11]
Air – indoor controlled	This environment is one to which the specified internal or external surface of the component or structure is exposed; a humidity-controlled (i.e., air conditioned) environment. For electrical purposes, control must be sufficient to eliminate the cited aging effects of contamination and oxidation without affecting the resistance.
Air – indoor uncontrolled	Uncontrolled indoor air is associated with systems with temperatures higher than the dew point (i.e., condensation can occur, but only rarely; equipment surfaces are normally dry).
Air – indoor uncontrolled >35°C (>95°F) (Internal/External)	Uncontrolled indoor air >35°C (>95°F) is above a thermal stress threshold for elastomers (i.e., <95°F). It is an environment to which the internal or external surface of the component or structure can be exposed. If the ambient temperature is maintained <95°F, any resultant thermal aging of organic materials can be considered as insignificant over the 60-yr period of extended operation. [Ref. 3] However, elastomers can be subjected to aging effects from other factors, such as exposure to ozone, oxidation, and radiation.
Air – outdoor	The outdoor environment consists of moist, possibly salt-laden atmospheric air, ambient temperatures and humidity, and exposure to weather, including precipitation and wind. The component is exposed to air and local weather conditions, including salt water spray (if present). A component is considered susceptible to a wetted environment when it is submerged, has the potential to collect water, or is subject to external condensation.

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Term	Definition as used in this document
Air with borated water leakage	Air and untreated borated water leakage on indoor or outdoor systems with temperatures either above or below the dew point. The water from leakage is considered to be untreated, due to the potential for water contamination at the surface (germane to PWRs).
Air with leaking secondary-side water and/or steam	This environment applies to steel components in the pressure boundary and structural parts of the once-through steam generator that may be exposed to air with leaking secondary-side water and/or steam.
Air with metal temperature up to 288°C (550°F)	This environment is synonymous with the more commonly-used phrase "system temperature up to 288°C (550°F)."
Air with reactor coolant leakage	Air and reactor coolant or steam leakage on high temperature systems (germane to BWRs)
Air with steam or water leakage	Air and untreated steam or water leakage on indoor or outdoor systems with temperatures above or below the dew point.
Air, dry	Air that has been treated to reduce its dew point well below the system operating temperature. Within piping, unless otherwise specified, this encompasses either internal or external.
Air, moist	Air with enough moisture to facilitate the loss of material in steel caused by general, pitting, and crevice corrosion. Moist air in the absence of condensation also is potentially aggressive (e.g., under conditions where hygroscopic surface contaminants are present, etc.).
Any	This could be any indoor or outdoor environment where the aging effects are not dependent on environmental conditions.
Buried and underground	As referenced in AMP XI.M41, "Buried and Underground Piping and Tanks," buried piping and tanks are those in direct contact with soil or concrete (e.g., a wall penetration). Underground piping and tanks are below grade, but are contained within a tunnel or vault such that they are in contact with air and are located where access for inspection is restricted.

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Closed-cycle cooling water	Treated water subject to the closed-cycle cooling water chemistry program is included in this environment. Closed-cycle cooling water >60°C (>140°F) makes the SCC of stainless steel possible. Examples of descriptors that comprise this category can include: • chemically-treated, borated water, and treated component cooling water • demineralized water on one side and closed-cycle cooling water (treated water) on the other side • chemically treated borated water on the tube side and closed-cycle cooling water on the shell side.
Concrete	This environment consists of components embedded in concrete.
Condensation (internal/external)	Condensation on the surfaces of systems at temperatures below the dew point is considered “raw water” due to the potential for internal or external surface contamination. Under certain circumstances, the former terms “moist air” or “warm moist air” are subsumed by the definition of “condensation,” which describes an environment where there is enough moisture for corrosion to occur.
Containment environment (inert)	A drywell environment is made inert with nitrogen to render the primary containment atmosphere non-flammable by maintaining the oxygen content below 4% by volume during normal operation.
Diesel exhaust	This environment consists of gases, fluids, and particulates present in diesel engine exhaust.
Fuel oil	Diesel oil, No. 2 oil, or other liquid hydrocarbons used to fuel diesel engines. Fuel oil used for combustion engines may be contaminated with water, which may promote additional aging effects.

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Gas	Internal gas environments include dry air or inert, non-reactive gases. This generic term is used only with "Common Miscellaneous Material/Environment," where aging effects are not expected to degrade the ability of the structure or component to perform its intended function for the period of extended operation. The term "gas" is not meant to comprehensively include all gases in the fire suppression system. The GALL AMP XI.M26, "Fire Protection," is used for the periodic inspection and testing of the halon/carbon dioxide fire suppression system.
Ground water/soil	Ground water is subsurface water that can be detected in wells, tunnels, or drainage galleries, or that flows naturally to the earth's surface via seeps or springs. Soil is a mixture of organic and inorganic materials produced by the weathering of rock and clay minerals or the decomposition of vegetation. Voids containing air and moisture can occupy 30 to 60 percent [Ref.12] of the soil volume. Concrete subjected to a ground water/soil environment can be vulnerable to an increase in porosity and permeability, cracking, loss of material (spalling, scaling)/, or aggressive chemical attack. Other materials with prolonged exposures to ground water or moist soils are subject to the same aging effects as those systems and components exposed to raw water.
Lubricating oil	Lubricating oils are low-to-medium viscosity hydrocarbons that can contain contaminants and/or moisture. This definition also functionally encompasses hydraulic oil (non-water based). These oils are used for bearing, gear, and engine lubrication. The GALL AMP XI.M39, *Lubricating Oil Analysis,* addresses this environment. Piping, piping components, and piping elements, whether copper, stainless steel, or steel, when exposed to lubricating oil with some water, will have limited susceptibility to aging degradation due to general or localized corrosion.
Raw water	Raw water consists of untreated surface or ground water, whether fresh, brackish, or saline in nature. This includes water for use in open-cycle cooling water systems and may include potable water, water that is used for drinking or other personal use. See also "condensation."

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Reactor coolant	Reactor coolant is treated water in the reactor coolant system and connected systems at or near full operating temperature, including steam associated with BWRs.
Reactor coolant >250°C (>482°F)	Treated water above the thermal embrittlement threshold for CASS.
Reactor coolant >250°C (>482°F) and neutron flux	Treated water in the reactor coolant system and connected systems above the thermal embrittlement threshold for CASS.
Reactor coolant and high fluence (>1 x 10^{21} n/cm^2 E >0.1 MeV)	Reactor coolant subjected to a high fluence (>1 x 10^{21} n/cm^2 E >0.1 MeV).
Reactor coolant and neutron flux	The reactor core environment that will result in a neutron fluence exceeding 10^{17} n/cm^2 (E >1 MeV) at the end of the license renewal term.
Reactor coolant and secondary feedwater/steam	Water in the reactor coolant system and connected systems at or near full operating temperature and the PWR feedwater or steam at or near full operating temperature, subject to the secondary water chemistry program (GALL AMP XI.M2).
Secondary feedwater	Within the context of the recirculating steam generator, components such as steam generator feedwater impingement plate and support may be subjected to loss of material due to erosion in a secondary feedwater environment. More generally, the environment of concern is a secondary feedwater/steam combination.
Secondary feedwater/steam	PWR feedwater or steam at or near full operating temperature, subject to the secondary water chemistry program (GALL AMP XI.M2).
Sodium pentaborate solution	Treated water that contains a mixture of borax and boric acid.

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Soil	Soil is a mixture of inorganic materials produced by the weathering of rock and clay minerals, and organic material produced by the decomposition of vegetation. Voids containing air and moisture occupy 30 to 60 percent [Ref.26] of the soil volume. Properties of soil that can affect degradation kinetics include moisture content, pH, ion exchange capacity, density, and hydraulic conductivity. External environments included in the soil category consist of components at the air/soil interface, buried in the soil, or exposed to ground water in the soil. See also "ground water/soil."
Steam	The steam environment is managed by the BWR water chemistry program or PWR secondary plant water chemistry program. Defining the temperature of the steam is not considered necessary for analysis.
System temperature up to 288°C (550°F)	This environment consists of a metal temperature of BWR components <288°C (550°F).
System temperature up to 340°C (644°F)	This environment consists of a maximum metal temperature <340°C (644°F).
Treated borated water	Borated (PWR) water is a controlled water system The Chemical and Volume Control System (CVCS) maintains the proper water chemistry in the reactor coolant system while adjusting the boron concentration during operation to match long-term reactivity changes in the core.
Treated borated water >250°C (>482°F)	Treated water with boric acid above the 250°C (>482°F) thermal embrittlement threshold for CASS
Treated borated water >60°C (>140°F)	Treated water with boric acid in PWR systems above the 60°C (>140°F) SCC threshold for stainless steel

IX.D Selected Definitions & Use of Terms for Describing and Standardizing ENVIRONMENTS

Term	Definition as used in this document
Treated water	Treated water is water whose chemistry has been altered and is maintained (as evidenced by testing) in a state which differs from naturally-occurring sources so as to meet a desired set of chemical specifications. Treated water generally falls into one of two categories. (1) The first category is based on demineralized water and, with the possible exception of boric acid (for PWRs only), generally contains minimal amounts of any additions. This water is generally characterized by high purity, low conductivity, and very low oxygen content. This category of treated water is generally used as BWR coolant and PWR primary and secondary water. (2) The second category may but need not be based on demineralized water. It contains corrosion inhibitors and also may contain biocides or other additives. This water will generally be comparatively higher in conductivity and oxygen content than the first category of treated water. This category of treated water is generally used in HVAC systems, auxiliary boilers, and diesel engine cooling systems. Closed-cycle cooling water is a subset of this category of treated water
Treated water >60°C (>140°F)	Treated water above the 60°C stress corrosion cracking threshold for stainless steel
Waste water	Radioactive, potentially radioactive, or non-radioactive waters that are collected from equipment and floor drains. Waste waters may contain contaminants, including oil and boric acid, depending on location, as well as originally treated water that is not monitored by a chemistry program.
Water-flowing	Water that is refreshed; thus, it has a greater impact on leaching and can include rainwater, raw water, ground water, or water flowing under a foundation
Water-standing	Water that is stagnant and unrefreshed, thus possibly resulting in increased ionic strength up to saturation

E. Aging Effects

The following table explains the selected usage of many of the standardized aging effects due to associated aging mechanisms used in the preceding GALL AMR tables in Chapters II through VIII of GALL Report, Rev. 2.

IX.E Selected Use of Terms for Describing and Standardizing AGING EFFECTS

Term	Usage in this document
Changes in dimensions	Changes in dimension can result from various phenomena, such as void swelling and, on a macroscopic level, denting
Concrete cracking and spalling	Cracking and exfoliation of concrete as the result of freeze-thaw, aggressive chemical attack, and reaction with aggregates
Corrosion of connector contact surfaces	Corrosion of exposed connector contact surfaces when caused by borated water intrusion
Crack growth	Increase in crack size attributable to cyclic loading
Cracking	This term is synonymous with the phrase “crack initiation and growth” in metallic substrates. Cracking in concrete when caused by restraint shrinkage, creep, settlement, and aggressive environment.
Cracking, loss of bond, and loss of material (spalling, scaling)	Cracking, loss of bond, and loss of material (spalling, scaling) when caused by corrosion of embedded steel in concrete.
Cracks; distortion; increase in component stress level	Within concrete structures, cracks, distortion, and increase in component stress level when caused by settlement. Although settlement can occur in a soil environment, the symptoms can be manifested in either an air-indoor uncontrolled or air-outdoor environment.
Cumulative fatigue damage	Cumulative fatigue damage is due to fatigue, as defined by ASME Boiler and Pressure Vessel Code.
Denting	Denting in steam generators can result from corrosion of carbon steel tube support plates.
Expansion and cracking	Within concrete structures, expansion and cracking can result from reaction with aggregates.
Fatigue	Fatigue in metallic fuse holder clamps can result from ohmic heating, thermal cycling, electrical transients, frequent manipulation, and vibration. [Ref. 13]

IX.E Selected Use of Terms for Describing and Standardizing AGING EFFECTS

Term	Usage in this document
Fretting or lockup	Fretting is accelerated deterioration at the interface between contacting surfaces as the result of corrosion and slight oscillatory movement between the two surfaces. In essence, both fretting and lockup are due to mechanical wear.
Hardening and loss of strength	Hardening (loss of flexibility) and loss of strength (loss of ability to withstand tensile or compressive stress) can result from elastomer degradation of seals and other elastomeric components. Weathered elastomers can experience increased hardness, shrinkage, and loss of strength.
Increase in porosity and permeability, cracking, loss of material (spalling, scaling), loss of strength	Porosity and permeability, cracking, and loss of material (spalling, scaling) in concrete can increase due to aggressive chemical attack. In concrete, the loss of material (spalling, scaling) and cracking can result from the freeze-thaw processes. Loss of strength can result from leaching of calcium hydroxide in the concrete.
Increased resistance of connection	Increased resistance of connection is an aging effect that can be caused by the loosening of bolts resulting from thermal cycling and ohmic heating. [VI.A. LP-25, Ref. 14, 15] In Chapter VI AMR line-items, increased resistance to connection is also said to be caused by the following aging mechanisms: • chemical contamination, corrosion, and oxidation (in an air, indoor controlled environment, increased resistance of connection due to chemical contamination, corrosion and oxidation do not apply) [VI.A. LP-23] • thermal cycling, ohmic heating, electrical transients, vibration, chemical contamination, corrosion, and oxidation [VI.A. LP-30] • fatigue caused by frequent manipulation or vibration [VI.A. LP-31] • corrosion of connector contact surfaces caused by intrusion of borated water [VI.A. LP-36] • oxidation or loss of pre-load [VI.A. LP-39, VI.A. LP-48]

IX.E Selected Use of Terms for Describing and Standardizing AGING EFFECTS

Term	Usage in this document
Ligament cracking	Steel tube support plates can experience ligament cracking due to corrosion. As previously noted in IN 96-09, tube support plate signal anomalies found during eddy-current testing of SG tubes may be indicative of support plate damage or ligament cracking.
Loss of conductor strength	Transmission conductors can experience loss of conductor strength due to corrosion.
Loss of fracture toughness	Loss of fracture toughness can result from various aging mechanisms, including thermal aging embrittlement and neutron irradiation embrittlement
Loss of leak tightness	Steel airlocks can experience loss of leak tightness in the closed position resulting from mechanical wear of locks, hinges, and closure mechanisms
Loss of material	Loss of material may be due to general corrosion, boric acid corrosion, pitting corrosion, galvanic corrosion, crevice corrosion, erosion, fretting, flow-accelerated corrosion, MIC, fouling, selective leaching, wastage, wear, and aggressive chemical attack. In concrete structures, loss of material can also be caused by abrasion or cavitation or corrosion of embedded steel. For high-voltage insulators, loss of material can be attributed to mechanical wear or wind-induced abrasion. Ref. 14]
Loss of material, loss of form	In earthen water-control structures, the loss of material and loss of form can result from erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, and seepage.
Loss of mechanical function	Loss of mechanical function in Class 1 piping and components (such as constant and variable load spring hangers, guides, stops, sliding surfaces, and vibration isolators) fabricated from steel or other materials, such as Lubrite®, can occur through the combined influence of a number of aging mechanisms. Such aging mechanisms can include corrosion, distortion, dirt, overload, fatigue due to vibratory and cyclic thermal loads, or elastomer hardening. Clearances being less than the design requirements can also contribute to loss of mechanical function.

IX.E Selected Use of Terms for Describing and Standardizing AGING EFFECTS

Term	Usage in this document
Loss of preload	Loss of preload can be due to gasket creep, thermal effects (including differential expansion and creep or stress relaxation), and self-loosening (which includes vibration, joint flexing, cyclic shear loads, thermal cycles). [Ref. 15, 16]
Loss of prestress	Loss of prestress in structural steel anchorage components can result from relaxation, shrinkage, creep, or elevated temperatures.
Loss of sealing; leakage through containment	Loss of sealing and leakage through containment in such materials as seals, elastomers, rubber, and other similar materials can result from deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants). Loss of sealing in elastomeric phase bus enclosure assemblies can result from moisture intrusion.
None	Certain material/environment combinations may not be subject to significant aging mechanisms; thus, there are no relevant aging effects that require management.
Reduction in concrete anchor capacity due to local concrete degradation	Reduction in concrete anchor capacity due to local concrete degradation can result from a service-induced cracking or other concrete aging mechanisms.
Reduction in foundation strength, cracking, differential settlement	Reduction in foundation strength, cracking, and differential settlement can result from erosion of porous concrete subfoundation.
Reduction of heat transfer	Reduction of heat transfer can result from fouling on the heat transfer surface. Although in heat exchangers the tubes are the primary heat transfer component, heat exchanger internals, including tubesheets and fins, contribute to heat transfer and may be affected by the reduction of heat transfer due to fouling. Although GALL Report, Rev. 2 does not include reduction of heat transfer for any heat exchanger surfaces other than tubes, reduction in heat transfer is of concern for other heat exchanger surfaces.

IX.E Selected Use of Terms for Describing and Standardizing AGING EFFECTS

Term	Usage in this document
Reduced insulation resistance	Reduced insulation resistance is an aging effect used exclusively in GALL Report, Rev. 2 for Chapter VI, Electrical Components and is said to result from the following aging mechanisms: • thermal/thermoxidative degradation of organics/thermoplastics, radiation-induced oxidation, moisture/debris intrusion, and ohmic heating [VI.A.LP-26] • presence of salt deposits or surface contamination [VI.A.LP-28] • thermal/thermoxidative degradation of organics, radiolysis, and photolysis (UV sensitive materials only) of organics; radiation-induced oxidation; moisture intrusion [VI.A.LP-33, VI.A.LP-34] • moisture [VI.A.LP-35]
Reduction of neutron-absorbing capacity	Reduction of neutron-absorbing capacity can result from Boraflex degradation.
Reduction of strength and modulus	In concrete, reduction of strength and modulus can be attributed to elevated temperatures (>150°F general; >200°F local).
Reduction or loss of isolation function	Reduction or loss of isolation function in polymeric vibration isolation elements can result from elastomers exposed to radiation hardening, temperature, humidity, sustained vibratory loading.
Wall thinning	Wall thinning is a specific type of loss of material attributed in the AMR line-items to general corrosion or flow-accelerated corrosion.

F. Significant Aging Mechanisms

An aging mechanism is considered to be significant when it may result in aging effects that produce a loss of functionality of a component or structure during the current or license renewal period if allowed to continue without mitigation.

The following table defines many of the standardized aging mechanisms used in the preceding GALL AMR tables in Chapters II through VIII of GALL Report, Rev. 2.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Abrasion	As used in the context of GALL Chpt III, “Structures and Component Supports,” as water migrates over a concrete surface, it may transport material that can abrade the concrete. The passage of water also may create a negative pressure at the water/air-to-concrete interface that can result in abrasion and cavitation degradation of the concrete. This may result in pitting or aggregate exposure due to loss of cement paste. [Ref. 17]
Aggressive chemical attack	Concrete, being highly alkaline (pH >12.5), is degraded by strong acids. Chlorides and sulfates of potassium, sodium, and magnesium may attack concrete, depending on their concentrations in soil/ground water that comes into contact with the concrete. Exposed surfaces of Class 1 structures may be subject to sulfur-based acid-rain degradation. The minimum thresholds causing concrete degradation are 500 ppm chlorides and 1500 ppm sulfates. [Ref. 17]
Boraflex degradation	Boraflex degradation may involve gamma radiation-induced shrinkage of Boraflex and the potential to develop tears or gaps in the material. A more significant potential degradation is the gradual release of silica and the depletion of boron carbide from Boraflex, following gamma irradiation and long-term exposure to the wet pool environment. The loss of boron carbide from Boraflex is characterized by slow dissolution of the Boraflex matrix from the surface of the Boraflex and a gradual thinning of the material. The boron carbide loss can result in a significant increase in the reactivity within the storage racks. An additional consideration is the potential for silica transfer through the fuel transfer canal into the reactor core during refueling operations and its effect on the fuel-clad heat transfer capability. [Ref. 18]

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Borated Water Intrusion	The influx of borated water.
Boric acid corrosion	Corrosion by boric acid, which can occur where there is borated water leakage in an environment described as air with borated water leakage (see Corrosion).
Cavitation	Formation and instantaneous collapse of innumerable tiny voids or cavities within a liquid subjected to rapid and intense pressure changes. Cavitation caused by severe turbulent flow can potentially lead to cavitation damage.
Chemical contamination	Presence of chemicals that do not occur under normal conditions at concentrations that could result in the degradation of the component.
Cladding breach	This refers to the various aging mechanisms breaking metallic cladding via any applicable process. Unique problems with stainless cladding have been identified for HHSI pumps as discussed in NRC Information Notice 94-63, "Boric Acid Corrosion of Charging Pump Casings Caused by Cladding Cracks." It is only used in AMR line-items in the Engineered Safety Features and Auxiliary System to describe the loss of material in PWR emergency core cooling system pump casing constructed of steel with stainless steel cladding and the PWR chemical and volume control system pump casing constructed of steel with stainless steel cladding.
Cladding degradation	This refers to the degradation of the stainless steel cladding via any applicable degradation process and is a precursor to cladding breach. It is only used to describe the loss of material due to pitting and crevice corrosion (only for steel after lining/cladding degradation) of piping, piping components, and piping elements fabricated from steel, with elastomer lining or stainless steel cladding.
Corrosion	Chemical or electrochemical reaction between a material, usually a metal, and the environment or between two dissimilar metals that produces a deterioration of the material and its properties.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Corrosion of carbon steel tube support plate	Corrosion can occur on the carbon steel tube support plates, which are plate-type components providing tube-to-tube mechanical support for the tubes in the tube bundle of the steam generator (recirculating) system of a PWR. The tubes pass through drilled holes in the plate. The secondary coolant flows through the tube supports via flow holes between the tubes. [Ref. 19, 20]
Corrosion of embedded steel	If the pH of concrete in which steel is embedded is reduced below 11.5 by intrusion of aggressive ions (e.g., chlorides > 500 ppm) in the presence of oxygen, embedded steel may corrode. A reduction in pH may be caused by the leaching of alkaline products through cracks, entry of acidic materials, or carbonation. Chlorides may be present in the constituents of the original concrete mix. The severity of the corrosion is affected by the properties and types of cement, aggregates, and moisture content. [Ref. 21]
Creep	Creep, for a metallic material, refers to a time-dependent continuous deformation process under constant stress. It is an elevated temperature process and is not a concern for low-alloy steel below 700°F, for austenitic alloys below 1000°F, or for Ni-based alloys below 1800°F. [Ref.22, 23] Creep, in concrete, is related to the loss of absorbed water from the hydrated cement paste. It is a function of the modulus of elasticity of the aggregate. It may result in loss of prestress in the tendons used in prestressed concrete containment. [Ref. 19]
Crevice corrosion	Crevice corrosion occurs in a wetted or buried environment when a crevice or area of stagnant or low flow exists that allows a corrosive environment to develop in a component. It occurs most frequently in joints and connections, or points of contact between metals and non-metals, such as gasket surfaces, lap joints, and under bolt heads. Carbon steel, cast iron, low alloy steels, stainless steel, copper, and nickel base alloys are all susceptible to crevice corrosion. Steel can be subject to crevice corrosion in some cases after lining/cladding degradation. Localized corrosion of a metal surface at, or immediately adjacent to, an area that is shielded from full exposure to the environment because of the close proximity of the metal to the surface of another dissimilar material.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Cyclic loading	One source of cyclic loading is the periodic application of pressure loads and forces due to thermal movement of piping transmitted through penetrations and structures to which penetrations are connected. The typical result of cyclic loads on metal components is fatigue cracking and failure; however, the cyclic loads also may cause changes in dimensions that result in functional failure.
Deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants) are subject to loss of sealing and leakage due to containment caused by aging degradation of these components.
Distortion	The aging mechanism of distortion (as associated with component supports in GALL Chpt III.B2) can be caused by time-dependent strain or by gradual elastic and plastic deformation of metal that is under constant stress at a value lower than its normal yield strength.
Elastomer degradation	Elastomer materials are substances whose elastic properties are similar to those of natural rubber. The term elastomer is sometimes used to technically distinguish synthetic rubbers and rubber-like plastics from natural rubber. Degradation may include mechanisms such as cracking, crazing, fatigue breakdown, abrasion, chemical attacks, and weathering. [Ref. 24, 25]
Electrical transients	An electrical transient is a stressor caused by a voltage spike that can contribute to aging degradation. Certain types of high-energy electrical transients can contribute to electromechanical forces, ultimately resulting in fatigue or loosening of bolted connections. Transient voltage surges are a major contributor to the early failure of sensitive electrical components
Elevated temperature	Elevated temperature is referenced as an aging mechanism only in the context of LWR containments (GALL Chpt. II). In concrete, reduction of strength and modulus can be attributed to elevated temperatures (>150°F general; >200°F local).
Erosion	Erosion, or the progressive loss of material from a solid surface, is due to mechanical interaction between that surface and a fluid, a multicomponent fluid, or solid particles carried by the fluid.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Erosion settlement	Erosion settlement is the subsidence of a containment structure that may occur due to changes in the site conditions, e.g., erosion or changes in the water table). The amount of settlement depends on the foundation material. [Ref. 21] Another synonymous term is “erosion of the porous concrete subfoundation.”
Erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, seepage	In earthen water-control structures, the loss of material and loss of form can result from erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, and seepage.
Fatigue	Fatigue is a phenomenon leading to fracture under repeated or fluctuating stresses having a maximum value less than the tensile strength of the material. Fatigue fractures are progressive, and grow under the action of the fluctuating stress. Fatigue due to vibratory and cyclic thermal loads is defined as the structural degradation that can occur from repeated stress/strain cycles caused by fluctuating loads (e.g., from vibratory loads) and temperatures, giving rise to thermal loads. After repeated cyclic loading of sufficient magnitude, microstructural damage may accumulate, leading to macroscopic crack initiation at the most vulnerable regions. Subsequent mechanical or thermal cyclic loading may lead to growth of the initiated crack. Vibration may result in component cyclic fatigue, as well as in cutting, wear, and abrasion, if left unabated. Vibration is generally induced by external equipment operation. It may also result from flow resonance or movement of pumps or valves in fluid systems. Crack initiation and growth resistance is governed by factors including stress range, mean stress, loading frequency, surface condition, and the presence of deleterious chemical species. [Ref. 26]
Flow-accelerated corrosion (FAC)	Flow-accelerated corrosion, also termed “erosion-corrosion,” is a co-joint activity involving corrosion and erosion in the presence of a moving corrosive fluid, leading to the accelerated loss of material. Susceptibility may be determined using the review process outlined in Section 4.2 of NSAC-202L-R2 and -R3 recommendations for an effective FAC program. [Ref. 27]

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Fouling	Fouling is an accumulation of deposits on the surface of a component or structure. This term includes accumulation and growth of aquatic organisms on a submerged metal surface or the accumulation of deposits (usually inorganic) on heat exchanger tubing. Biofouling, a subset of fouling, can be caused by either macro-organisms (e.g., barnacles, Asian clams, zebra mussels, and others found in fresh and salt water) or micro-organisms (e.g., algae, etc.). Fouling also can be categorized as particulate fouling from sediment, silt, dust, and corrosion products, or marine biofouling, or macrofouling (e.g., peeled coatings, debris, etc.). Fouling in a raw water system can occur on the piping, valves, and heat exchangers. Fouling can result in a reduction of heat transfer or loss of material.
Freeze-thaw, frost action	Repeated freezing and thawing can cause severe degradation of concrete, characterized by scaling, cracking, and spalling. The cause is water freezing within the pores of the concrete, creating hydraulic pressure. If unrelieved, this pressure will lead to freeze-thaw degradation. If the temperature cannot be controlled, other factors that enhance the resistance of concrete to freeze-thaw degradation are (a) adequate air content (i.e., within ranges specified in ACI 301-84), (b) low permeability, (c) protection until adequate strength has developed, and (d) surface coating applied to frequently wet-dry surfaces. [Ref. 21, 28]
Fretting	Fretting is an aging effect due to accelerated deterioration at the interface between contacting surfaces that experience a slight, differential oscillatory movement as the result of corrosion.
Galvanic corrosion	Galvanic corrosion is accelerated corrosion of a metal because of an electrical contact with a more noble metal or nonmetallic conductor in a corrosive electrolyte. It is also called bimetallic corrosion, contact corrosion, dissimilar metal corrosion, or two-metal corrosion. Galvanic corrosion is an applicable aging mechanism for steel materials coupled to more noble metals in heat exchangers; galvanic corrosion of copper is of concern when coupled with the nobler stainless steel.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
General corrosion	General corrosion, also known as uniform corrosion, proceeds at approximately the same rate over a metal surface. Loss of material due to general corrosion is an aging effect requiring management for low-alloy steel, carbon steel, and cast iron in outdoor environments. Some potential for pitting and crevice corrosion may exist even when pitting and crevice corrosion is not explicitly listed in the aging effects/aging mechanism column in GALL Report, Rev. 2 AMR Items and when the descriptor may only be loss of material due to general corrosion. For example, the AMP XI.M36, "External Surfaces Monitoring of Mechanical Components," calls for the inspection of general corrosion of steel through visual inspection of external surfaces for evidence of material loss and leakage. It acts as a de facto screening for pitting and crevice corrosion, since the symptoms of general corrosion will be noticed first. Wastage is thinning of component walls due to general corrosion.
Intergranular attack (IGA)	In austenitic stainless steels, the precipitation of chromium carbides, usually at grain boundaries, on exposure to temperatures of about 550-850°C, leaves the grain boundaries depleted of Cr and, therefore, susceptible to preferential attack (intergranular attack) by a corroding (oxidizing) medium.
Intergranular stress corrosion cracking (IGSCC)	IGSCC is SCC in which the cracking occurs along grain boundaries.
Irradiation-assisted stress corrosion cracking (IASCC)	Failure by intergranular cracking in aqueous environments of stressed materials exposed to ionizing radiation has been termed irradiation-assisted stress corrosion cracking (IASCC). Irradiation by high-energy neutrons can promote SCC by affecting material microchemistry (e.g., radiation-induced segregation of elements such as P, S, Si, and Ni to the grain boundaries), material composition and microstructure (e.g., radiation hardening), as well as water chemistry (e.g., radiolysis of the reactor water to make it more aggressive).

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Leaching of calcium hydroxide and carbonation	Water passing through cracks, inadequately prepared construction joints, or areas that are not sufficiently consolidated during placing may dissolve some calcium-containing products (of which calcium hydroxide is the most-readily soluble, depending on the solution pH) in concrete. Once the calcium hydroxide has been leached away, other cementatious constituents become vulnerable to chemical decomposition, finally leaving only the silica and alumina gels behind with little strength. The water's aggressiveness in the leaching of calcium hydroxide depends on its salt content, pH, and temperature. This leaching action is effective only if the water passes through the concrete. [Ref. 21]
Low-temperature crack propagation	Low-temperature crack propagation (LTCP) is IGSCC at low temperatures (~130-170°F).
Mechanical loading	Applied loads of mechanical origins rather than from other sources, such as thermal.
Mechanical wear	See "Wear."
Microbiologically-influenced corrosion (MIC)	Any of the various forms of corrosion influenced by the presence and activities of such microorganisms as bacteria, fungi, and algae, and/or the products produced in their metabolism. Degradation of material that is accelerated due to conditions under a biofilm or microfouling tubercle, for example, anaerobic bacteria that can set up an electrochemical galvanic reaction or inactivate a passive protective film, or acid-producing bacterial that might produce corrosive metabolites.
Moisture intrusion	Influx of moisture through any viable process.
Neutron irradiation embrittlement	Irradiation by neutrons results in embrittlement of carbon and low-alloy steels. It may produce changes in mechanical properties by increasing tensile and yield strengths with a corresponding decrease in fracture toughness and ductility. The extent of embrittlement depends on neutron fluence, temperature, and trace material chemistry. [Ref. 23]

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Ohmic heating	Ohmic heating is induced by current flow through a conductor and can be calculated using first principles of electricity and heat transfer. Ohmic heating is a thermal stressor and can be induced by conductors passing through electrical penetrations, for example. Ohmic heating is especially significant for power circuit penetrations. [Ref. 14]
Outer diameter stress corrosion cracking (ODSCC)	ODSCC is SCC initiating in the outer diameter (secondary side) surface of steam generator tubes. The secondary side is part of the secondary system consisting of the shell side of the steam generator, high- and low-pressure turbines, moisture/separator reheaters, main electrical stages and interconnecting piping. This differs from PWSCC, which describes inner diameter (SG primary side) initiated cracking. [Ref. 20] The primary loop basically consists of the reactor vessel, reactor coolant pumps, pressurizer steam generator tubes, and interconnecting piping.
Overload	Overload is one of the aging mechanisms that can cause loss of mechanical function in Class 1 piping and components, such as constant and variable load spring hangers, guides, stops, sliding surfaces, design clearances, and vibration isolators, fabricated from steel or other materials, such as Lubrite®.
Oxidation	Oxidation involves two types of reactions: (a) an increase in valence resulting from a loss of electrons, or (b) a corrosion reaction in which the corroded metal forms an oxide. [Ref. 24]
Photolysis	Chemical reactions induced or assisted by light
Pitting corrosion	Localized corrosion of a metal surface, confined to a point or small area, which takes the form of cavities called pits
Plastic deformation	Time-dependent strain, or gradual elastic and plastic deformation, of metal that is under constant stress at a value lower than its normal yield strength

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Presence of any salt deposits	The surface contamination (and increased electrical conductivity) resulting from the aggressive environment associated with the presence of salt deposits can degrade high voltage insulator quality. Although this aging mechanism may be due to temporary, transient environmental conditions, the net result may be long-lasting and cumulative for plants located in the vicinity of saltwater bodies.
Primary water stress corrosion cracking (PWSCC)	PWSCC is an intergranular cracking mechanism that requires the presence of high applied and/or residual stress, susceptible tubing microstructures (few intergranular carbides), and also high temperatures. This aging mechanism is most likely a factor for nickel alloys in the PWR environment. [Ref. 19]
Radiation hardening, temperature, humidity, sustained vibratory loading	Reduction or loss of isolation function in polymeric vibration isolation elements can result from a combination of radiation hardening, temperature, humidity, and sustained vibratory loading.
Radiation-induced oxidation	Two types of reactions that are affected by radiation are (a) an increase in valence resulting from a loss of electrons, or (b) a corrosion reaction in which the corroded metal forms an oxide. This is a very limited form of oxidation and is referenced in GALL Chpt. VI for MEB insulation. [Ref. 24]
Radiolysis	Radiolysis is a chemical reaction induced or assisted by radiation. Radiolysis and photolysis aging mechanisms can occur in UV-sensitive organic materials.
Reaction with aggregate	The presence of reactive alkalis in concrete can lead to subsequent reactions with aggregates that may be present. These alkalis are introduced mainly by cement, but also may come from admixtures, salt-contamination, seawater penetration, or solutions of deicing salts. These reactions include alkali-silica reactions, cement-aggregate reactions, and aggregate-carbonate reactions. These reactions may lead to expansion and cracking. [Ref. 11, 29]
Restraint shrinkage	Restraint shrinkage can cause cracking in concrete transverse to the longitudinal construction joint.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Selective leaching	Selective leaching is also known as dealloying (e.g., dezincification or graphitic corrosion) and involves selective corrosion of one or more components of a solid solution alloy.
Service-induced cracking or other concrete aging mechanisms	Cracking of concrete under load over time of service (e.g., from shrinkage or creep, or other concrete aging mechanisms) that may include freeze-thaw, leaching, aggressive chemicals, reaction with aggregates, corrosion of embedded steels, elevated temperatures, irradiation, abrasion, and cavitation [Ref. 17]
Settlement	This term is referenced as an aging mechanism in GALL Chpt. II, *Containment Structures*. Settlement of a containment structure may occur due to changes in the site conditions (e.g., water table, etc.). The amount of settlement depends on the foundation material. [Ref. 20]
Stress corrosion cracking (SCC)	SCC is the cracking of a metal produced by the combined action of corrosion and tensile stress (applied or residual), especially at elevated temperature. SCC is highly chemically specific in that certain alloys are likely to undergo SCC only when exposed to a small number of chemical environments. For PWR internal components, in Chapters IV.B2, IV.B3 and IV.B4, SCC includes intergranular stress corrosion cracking, transgranular stress corrosion cracking, primary water stress corrosion cracking, and low temperature crack propagation as aging mechanisms.
Stress relaxation	Many of the bolts in reactor internals are stressed to a cold initial preload. When subject to high operating temperatures, over time these bolts may loosen and the preload may be lost. Radiation can also cause stress relaxation in highly stressed members such as bolts. [Ref. 15] Relaxation in structural steel anchorage components can be an aging mechanism contributing to the aging effect of loss of prestress.
Surface contamination	Contamination of the surfaces by corrosive constituents or fouling.
Sustained vibratory loading	Vibratory loading over time

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Thermal aging embrittlement	Also termed “thermal aging” or “thermal embrittlement.” At operating temperatures of 500 to 650°F, cast austenitic stainless steels (CASS) exhibit a spinoidal decomposition of the ferrite phase into ferrite-rich and chromium-rich phases. This may give rise to significant embrittlement (reduction in fracture toughness), depending on the amount, morphology, and distribution of the ferrite phase and the composition of the steel. Thermal aging of materials other than CASS is a time- and temperature-dependent degradation mechanism that decreases material toughness. It includes temper embrittlement and strain aging embrittlement. Ferritic and low-alloy steels are subject to both of these types of embrittlement, but wrought stainless steel is not affected by either of these processes. [Ref. 23]
Thermal effects, gasket creep, and self-loosening	Loss of preload due to gasket creep, thermal effects (including differential expansion and creep or stress relaxation), and self-loosening (which includes vibration, joint flexing, cyclic shear loads, thermal cycles) [Ref. 15, 16]
Thermal and mechanical loading	Loads (stress) due to mechanical or thermal (temperature) sources
Thermal degradation of organic materials	Organic materials, in this case, are polymers. This category includes both short-term thermal degradation and long-term thermal degradation. Thermal energy absorbed by polymers can result in crosslinking and chain scission. Crosslinking will generally result in such aging effects as increased tensile strength and hardening of material, with some loss of flexibility and eventual decrease in elongation-at-break and increased compression set. Scission generally reduces tensile strength. Other reactions that may occur include crystallization and chain depolymerization.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Thermal fatigue	Fatigue is the progressive and localized structural damage that occurs when a material is subjected to cyclic loading. The maximum stress values are less than the ultimate tensile stress limit, and may be below the yield stress limit of the material. Higher temperatures generally decrease fatigue strength. Thermal fatigue can result from phenomena such as thermal loading, thermal cycling, where there is cycling of the thermal loads, and thermal stratification and turbulent penetration. Thermal stratification is a thermo-hydraulic condition with a definitive hot and cold water boundary inducing thermal fatigue of the piping. Turbulent penetration is a thermo-hydraulic condition where hot and cold water mix as a result of turbulent flow conditions, leading to thermal fatigue of the piping. The GALL AMP XI.M32, “One-Time Inspection,” inspects for cracking induced by thermal stratification, and for turbulent penetration via volumetric (RT or UT) techniques.
Thermoxidative degradation of organics/thermoplastics	Degradation of organics/thermoplastics via oxidation reactions (loss of electrons by a constituent of a chemical reaction) and thermal means (see Thermal degradation of organic materials). [Ref. 22]
Transgranular stress corrosion cracking	Transgranular stress corrosion cracking (TGSCC) is stress corrosion cracking in which cracking occurs across the grains
Void swelling	Vacancies created in reactor (metallic) materials as a result of irradiation may accumulate into voids that may, in turn, lead to changes in dimensions (swelling) of the material. Void swelling may occur after an extended incubation period.
Water trees	Water trees occur when the insulating materials are exposed to long-term electrical stress and moisture; these trees eventually result in breakdown of the dielectric and ultimate failure. The growth and propagation of water trees is somewhat unpredictable. Water treeing is a degradation and long-term failure phenomenon.

IX.F Selected Definitions & Use of Terms for Describing and Standardizing AGING MECHANISMS

Term	Definition as used in this document
Wear	Wear is defined as the removal of surface layers due to relative motion between two surfaces or under the influence of hard, abrasive particles. Wear occurs in parts that experience intermittent relative motion, frequent manipulation, or in clamped joints where relative motion is not intended, but may occur due to a loss of the clamping force. [Ref. 23]
Weathering	Weathering is the mechanical or chemical degradation of external surfaces of materials when exposed to an outside environment.
Wind-induced abrasion	(See Abrasion) The fluid carrier of abrading particles is wind rather than water/liquids.

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18. NRC GL 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks," NRC, Rockville, MD, 1996.

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CHAPTER X

TIME-LIMITED AGING ANALYSES EVALUATION OF AGING MANAGEMENT PROGRAMS UNDER 10 CFR 54.21(C)(1)(iii)

TIME-LIMITED AGING ANALYSES (TLAAs)

X.M1 FATIGUE MONITORING

Program Description

Fatigue usage factor is a computed mechanical parameter suitable for gauging fatigue damage in components subjected to fluctuating stresses. Crack initiation is assumed to have started in a structural component when the fatigue usage factor at a point of the component reaches the value of 1, the design limit on fatigue. In order not to exceed the design limit on fatigue usage, the aging management program (AMP) monitors and tracks the number of critical thermal and pressure transients for the selected components. The program also verifies that the severity of the monitored transients are bounded by the design transient definition for which they are classified.

The AMP addresses the effects of the reactor coolant environment on component fatigue life (to determine an environmentally-adjusted cumulative usage factor, or CUF_{en}) by assessing the impact of the reactor coolant environment on a set of sample critical components for the plant. Examples of critical components are identified in NUREG/CR-6260. Environmental effects on fatigue for these critical components may be evaluated using one of the following sets of formulae:

- <u>Carbon and Low Alloy Steels</u>
  - Those provided in NUREG/CR-6583, using the applicable ASME Section III fatigue design curve
  - Those provided in Appendix A of NUREG/CR-6909, using either the applicable ASME Section III fatigue design curve or the fatigue design curve for carbon and low alloy steel provided in NUREG/CR-6909 (Figures A.1 and A.2, respectively, and Table A.1)
  - A staff approved alternative

- <u>Austenitic Stainless Steels</u>
  - Those provided in NUREG/CR-5704, using the applicable ASME Section III fatigue design curve
  - Those provided in NUREG/CR-6909, using the fatigue design curve for austenitic stainless steel provided in NUREG/CR-6909 (Figure A.3 and Table A.2)
  - A staff approved alternative

- <u>Nickel Alloys</u>
  - Those provided in NUREG/CR-6909, using the fatigue design curve for austenitic stainless steel provided in NUREG/CR-6909 (Figure A.3 and Table A.2)
  - A staff approved alternative

Any one option may be used for calculating the CUF_{en} for each material.

Evaluation and Technical Basis

1. ***Scope of Program:*** The scope includes those components that have been identified to have a fatigue TLAA. The program monitors and tracks the number of critical thermal and pressure transients for the selected components. The program ensures the fatigue usage remaining within the allowable limit, thus minimizing fatigue cracking of metal components caused by anticipated cyclic strains in the material.

   For purposes of monitoring and tracking, applicants should include, for a set of sample reactor coolant system components, fatigue usage calculations that consider the effects of the reactor water environment. This sample set should include the locations identified in NUREG/CR-6260 and additional plant-specific component locations in the reactor coolant pressure boundary if they may be more limiting than those considered in NUREG/CR-6260.

2. ***Preventive Actions:*** The program prevents the fatigue TLAAs from becoming invalid by assuring that the fatigue usage resulting from actual operational transients does not exceed the Code design limit of 1.0, including environmental effects where applicable. This could be caused by the numbers of actual plant transients exceeding the numbers used in the fatigue analyses or by the actual transient severity exceeding the bounds of the design transient definitions. However, in either of these cases, if the analysis is revised to account for the increased number or severity of transients such that the CUF value remains below 1.0, the program remains effective.

3. ***Parameters Monitored/Inspected:*** The program monitors all plant design transients that cause cyclic strains, which are significant contributors to the fatigue usage factor. The number of occurrences of the plant transients that cause significant fatigue usage for each component is to be monitored. Alternatively, more detailed monitoring of local pressure and thermal conditions may be performed to allow the actual fatigue usage for the specified critical locations to be calculated.

4. ***Detection of Aging Effects:*** The program provides for updates of the fatigue usage calculations on an as-needed basis if an allowable cycle limit is approached, or in a case where a transient definition has been changed, unanticipated new thermal events are discovered, or the geometry of components have been modified.

5. ***Monitoring and Trending:*** Trending is assessed to ensure that the fatigue usage factor remains below the design limit during the period of extended operation, thus minimizing fatigue cracking of metal components caused by anticipated cyclic strains in the material.

6. ***Acceptance Criteria:*** The acceptance criterion is maintaining the cumulative fatigue usage below the design limit through the period of extended operation, with consideration of the reactor water environmental fatigue effects described in the program description and scope of program.

7. ***Corrective Actions:*** The program provides for corrective actions to prevent the usage factor from exceeding the design code limit during the period of extended operation. Acceptable corrective actions include repair of the component, replacement of the component, and a more rigorous analysis of the component to demonstrate that the design code limit will not be exceeded during the period of extended operation. Scope expansion includes consideration of other locations with the highest expected cumulative usage factors when considering environmental effects. As discussed in the Appendix for GALL, the staff

finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of Appendix B to 10 CFR Part 50. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** The program reviews industry experience relevant to fatigue cracking. Applicable operating experience relevant to fatigue cracking is to be considered in selecting the locations for monitoring. As discussed in NRC Regulatory Issue Summary 2008-30, the use of certain simplified analysis methodology to demonstrate compliance with the ASME Code fatigue acceptance criteria could be nonconservative; therefore, a confirmatory analysis is recommended.

References

NRC Regulatory Issue Summary 2008-30, *Fatigue Analysis of Nuclear Power Plant Components*, U.S. Nuclear Regulatory Commission, December 16, 2008.

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NUREG/CR-6909, *Effects of LWR Coolant Environments on the Fatigue Life of Reactor Materials,* U.S. Nuclear Regulatory Commission, February 2007.

X.S1 CONCRETE CONTAINMENT TENDON PRESTRESS

Program Description

This aging management program provides reasonable assurance of the adequacy of prestressing forces in prestressed concrete containment tendons during the period of extended operation under 10 CFR 54.21(c)(1)(iii). The program consists of an assessment of inspections performed in accordance with the requirements of Subsection IWL of the American Society of Mechanical Engineers (ASME) Code, Section XI, as supplemented by the requirements of 10 CFR 50.55a(b)(2)(viii). The assessment related to the adequacy of the prestressing force establishes (a) acceptance criteria in accordance with U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.35.1 and (b) trend lines based on the guidance provided in NRC Information Notice (IN) 99-10.

As evaluated below, this time-limited aging analysis (TLAA) is an acceptable option to manage containment tendon prestress forces. However, it is recommended that the staff further evaluate an applicant's operating experience related to the containment tendon prestress force. Programs related to the adequacy of prestressing force for containments with grouted tendons are reviewed on a case-by-case basis.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program addresses the assessment of containment tendon prestressing force when an applicant performs the containment prestress force TLAA using 10 CFR 54.21(c)(1)(iii).

2. ***Preventive Actions:*** Maintaining the prestress above the minimum required value (MRV), as described under the acceptance criteria below, ensures that the structural and functional adequacy of the containment are maintained.

3. ***Parameters Monitored:*** The parameters monitored are the containment tendon prestressing forces in accordance with requirements specified in Subsection IWL of Section XI of the ASME Code, as incorporated by reference in 10 CFR 50.55a.

4. ***Detection of Aging Effects:*** The loss of containment tendon prestressing forces is detected by the program.

5. ***Monitoring and Trending:*** The estimated and measured prestressing forces are plotted against time, and the predicted lower limit (PLL), MRV, and trending lines are developed for the period of extended operation. NRC RG 1.35.1 provides guidance for calculating PLL and MRV. The trend line represents the trend of prestressing forces based on the actual measured forces. NRC IN 99-10 provides guidance for constructing the trend line.

6. ***Acceptance Criteria:*** The prestressing force trend lines indicate that existing prestressing forces in the containment tendon would not be below the MRVs prior to the next scheduled inspection, as required by 10 CFR 50.55a(b)(2)(viii)(B). The acceptance criteria normally consists of PLL and the minimum required prestressing force, also called MRV. The goal is to keep the trend line above the PLL because, as a result of any inspection performed in accordance with ASME Section XI, Subsection IWL, if the trend line crosses the PLL, the existing prestress in the containment tendon could go below the MRV soon after the inspection and would not meet the requirements of 10 CFR 50.55a(b)(2)(viii)(B).

7. ***Corrective Actions:*** If acceptance criteria are not met, then either systematic retensioning of tendons or a reanalysis of the containment is warranted to ensure the design adequacy of the containment. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** The confirmation process ensures that preventive actions are adequate and that appropriate corrective actions have been completed and are effective. The confirmation process for this program is implemented through the site's quality assurance (QA) program in accordance with the requirements of 10 CFR Part 50, Appendix B.

9. ***Administrative Controls:*** The administrative controls for this program provide for a formal review and approval of corrective actions. The administrative controls for this program are implemented through the site's QA program in accordance with the requirements of 10 CFR Part 50, Appendix B.

10. ***Operating Experience:*** The program incorporates the relevant operating experience that has occurred at the applicant's plant as well as at other plants. The applicable portions of the experience with prestressing systems described in NRC IN 99-10 could be useful. Additional industry operating experience has been documented in NUREG/CR-4652 and in the May/June 1994 *Concrete International* publication by H. Ashar, C. P. Tan, and D. Naus. However, tendon operating experience may be different at plants with prestressed concrete containments. The difference could be due to the prestressing system design (e.g., button-headed, wedge, or swaged anchorages), environment, and type of reactor (i.e., pressurized water reactor and boiling water reactor). Thus, the applicant's plant-specific operating experience should be further evaluated for license renewal.

References

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ASME Section XI, *Rules for In-Service Inspection of Nuclear Power Plant Components, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants*, 1992 Edition with 1992 Addenda, The ASME Boiler and Pressure Vessel Code, The American Society of Mechanical Engineers, New York, NY.

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X.E1 ENVIRONMENTAL QUALIFICATION (EQ) OF ELECTRIC COMPONENTS

Program Description

The Nuclear Regulatory Commission (NRC) has established nuclear station environmental qualification (EQ) requirements in 10 CFR Part 50, Appendix A, Criterion 4, and 10 CFR 50.49. 10 CFR 50.49 specifically requires that an EQ program be established to demonstrate that certain electrical components located in harsh plant environments (that is, those areas of the plant that could be subject to the harsh environmental effects of a loss of coolant accident (LOCA), high energy line breaks, or post-LOCA environment) are qualified to perform their safety function in those harsh environments after the effects of inservice aging. 10 CFR 50.49 requires that the effects of significant aging mechanisms be addressed as part of environmental qualification.

All operating plants shall meet the requirements of 10 CFR 50.49 for certain electrical 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 the environmental conditions to which the components could be subjected. 10 CFR 50.49(e)(5) contains 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)(5) also requires replacement or refurbishment of components not qualified for the current license term 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. 10 CFR 50.49(k) and (i) permit different qualification criteria to apply based on plant and component vintage. Supplemental EQ regulatory guidance for compliance with these different qualification criteria is provided in the Division of Operating Reactors (DOR) Guidelines; Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors; NUREG-0588, “Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment”; and Regulatory Guide 1.89, Rev. 1, “Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants.” Compliance with 10 CFR 50.49 provides reasonable assurance that the component can perform its intended functions during accident conditions after experiencing the effects of inservice aging.

EQ programs manage component thermal, radiation, and cyclical aging through the use of aging evaluations based on 10 CFR 50.49(f) qualification methods. As required by 10 CFR 50.49, EQ components not qualified for the current license term are refurbished, replaced, or have their qualification extended prior to reaching the aging limits established in the evaluation. Aging evaluations for EQ components that specify a qualification of at least 40 years are considered time-limited aging analyses (TLAAs) for license renewal.

Under 10 CFR 54.21(c)(1)(iii), plant EQ programs, which implement the requirements of 10 CFR 50.49 (as further defined and clarified by the DOR Guidelines, NUREG-0588, and Regulatory Guide 1.89, Rev. 1), are viewed as aging management programs (AMPs) for license renewal. Reanalysis of an aging evaluation to extend the qualification of components under 10 CFR 50.49(e) is performed on a routine basis as part of an EQ program. Important attributes for the reanalysis of an aging evaluation include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met). These attributes are discussed in the "EQ Component Reanalysis Attributes" section.

This reanalysis program can be applied to EQ components now qualified for the current operating term (i.e., those components now qualified for 40 years or more). As evaluated below, this is an acceptable AMP. Thus, no further evaluation is recommended for license renewal if an applicant elects this option under 10 CFR 54.21(c)(1)(iii) to evaluate the TLAA of EQ of electric equipment. The reanalysis showing the 60-year qualification is established prior to the plant entering the period of extended operation. As defined in 10 CFR 50.49(j), a record of the qualification must be maintained in an auditable form for the entire period of extended operation during which the covered item is installed in the nuclear power plant or is stored for future use; this permits verification that each item of electric equipment important to safety covered by this section (a) is qualified for its application and (b) meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform a safety function up to the end of qualified life.

EQ Component Reanalysis Attributes

The reanalysis of an aging evaluation is normally performed to extend the qualification by reducing excess conservatism incorporated in the prior evaluation. Reanalysis of an aging evaluation to extend the qualification of a component is performed on a routine basis pursuant to 10 CFR 50.49(e) as part of an EQ program. While a component life limiting condition may be due to thermal, radiation, or cyclical aging, the vast majority of component aging limits are based on thermal conditions. Conservatism may exist in aging evaluation parameters, such as the assumed ambient temperature of the component, an unrealistically low activation energy, or in the application of a component (de-energized versus energized). The reanalysis of an aging evaluation is documented according to the station's quality assurance program requirements, which requires the verification of assumptions and conclusions. As already noted, important attributes of a reanalysis include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met). These attributes are discussed below.

Analytical Methods: The analytical models used in the reanalysis of an aging evaluation are the same as those previously applied during the prior evaluation. The Arrhenius methodology is an acceptable thermal model for performing a thermal aging evaluation. The analytical method used for a radiation aging evaluation is to demonstrate qualification for the total integrated dose (that is, normal radiation dose for the projected installed life plus accident radiation dose). For license renewal, one acceptable method of establishing the 60-year normal radiation dose is to multiply the 40-year normal radiation dose by 1.5 (that is, 60 years/40 years). The result is added to the accident radiation dose to obtain the total integrated dose for the component. For cyclical aging, a similar approach may be used. Other models may be justified on a case-by-case basis.

Data Collection and Reduction Methods: Reducing excess conservatism in the component service conditions (for example, temperature, radiation, cycles) used in the prior aging evaluation is the chief method used for a reanalysis. Temperature data used in an aging evaluation is conservative and based on plant design temperatures or on actual plant temperature data. When used, plant temperature data can be obtained in several ways, including monitors used for technical specification compliance, other installed monitors, measurements made by plant operators during rounds, and temperature sensors on large motors (while the motor is not running). A representative number of temperature measurements are conservatively evaluated to establish the temperatures used in an aging evaluation. Plant temperature data may be used in an aging evaluation in different ways, such as (a) directly applying the plant temperature data in the evaluation, or (b) using the plant temperature data to demonstrate conservatism when using plant design temperatures for an evaluation. Any changes to material activation energy values as part of a reanalysis are justified on a plant-specific basis. Similar methods of reducing excess conservatism in the component service conditions used in prior aging evaluations can be used for radiation and cyclical aging.

Underlying Assumptions: EQ component aging evaluations contain sufficient conservatism to account for most environmental changes occurring due to plant modifications and events. When unexpected adverse conditions are identified during operational or maintenance activities that affect the normal operating environment of a qualified component, the affected EQ component is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions.

Acceptance Criteria and Corrective Actions: The reanalysis of an aging evaluation could extend the qualification of the component. If the qualification cannot be extended by reanalysis, the component is refurbished, replaced, or requalified prior to exceeding the period for which the current qualification remains valid. A reanalysis is performed in a timely manner (that is, sufficient time is available to refurbish, replace, or requalify the component if the reanalysis is unsuccessful).

Evaluation and Technical Basis

1. ***Scope of Program:*** EQ programs apply to certain electrical components that are important to safety and could be exposed to harsh environment accident conditions, as defined in 10 CFR 50.49 and Regulatory Guide 1.89, Rev.1.

2. ***Preventive Actions:*** 10 CFR 50.49 does not require actions that prevent aging effects. EQ program actions that could be viewed as preventive actions include (a) establishing the component service condition tolerance and aging limits (for example, qualified life or condition limit) and (b) where applicable, requiring specific installation, inspection, monitoring, or periodic maintenance actions to maintain component aging effects within the bounds of the qualification basis.

3. ***Parameters Monitored/Inspected:*** EQ component qualified life is not based on condition or performance monitoring. However, pursuant to Regulatory Guide 1.89, Rev. 1, such monitoring programs are an acceptable basis to modify a qualified life through reanalysis. Monitoring or inspection of certain environmental conditions or component parameters may be used to ensure that the component is within the bounds of its qualification basis, or as a means to modify the qualified life.

4. ***Detection of Aging Effects:*** 10 CFR 50.49 does not require the detection of aging effects for in-service components. Monitoring or inspection of certain environmental conditions or component parameters may be used to ensure that the component is within the bounds of its qualification basis, or as a means to modify the qualified life.

5. ***Monitoring and Trending:*** 10 CFR 50.49 does not require monitoring and trending of component condition or performance parameters of in-service components to manage the effects of aging. EQ program actions that could be viewed as monitoring include monitoring how long qualified components have been installed. Monitoring or inspection of certain environmental, condition, or component parameters may be used to ensure that a

component is within the bounds of its qualification basis, or as a means to modify the qualification.

6. ***Acceptance Criteria:*** 10 CFR 50.49 acceptance criteria are that an inservice EQ component is maintained within the bounds of its qualification basis, including (a) its established qualified life and (b) continued qualification for the projected accident conditions. 10 CFR 50.49 requires refurbishment, replacement, or requalification prior to exceeding the qualified life of each installed device. When monitoring is used to modify a component qualified life, plant-specific acceptance criteria are established based on applicable 10 CFR 50.49(f) qualification methods.

7. ***Corrective Actions:*** If an EQ component is found to be outside the bounds of its qualification basis, corrective actions are implemented in accordance with the station's corrective action program. When unexpected adverse conditions are identified during operational or maintenance activities that affect the environment of a qualified component, the affected EQ component is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions. When an emerging industry aging issue is identified that affects the qualification of an EQ component, the affected component is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions. Confirmatory actions, as needed, are implemented as part of the station's corrective action program, pursuant to 10 CFR 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** Confirmatory actions, as needed, are implemented as part of the station's corrective action program, pursuant to 10 CFR 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls:*** EQ programs are implemented through the use of station policy, directives, and procedures. EQ programs continue to comply with 10 CFR 50.49 throughout the renewal period, including development and maintenance of qualification documentation demonstrating reasonable assurance that a component can perform required functions during harsh accident conditions. EQ program documents identify the applicable environmental conditions for the component locations. EQ program qualification files are maintained at the plant site in an auditable form for the duration of the installed life of the component. EQ program documentation is controlled under the station's quality assurance program. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** EQ programs include consideration of operating experience to modify qualification bases and conclusions, including qualified life. Compliance with 10 CFR 50.49 provides reasonable assurance that components can perform their intended functions during accident conditions after experiencing the effects of inservice aging.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.49, *Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 54.21, *Contents of Application—Technical Information*, Office of the Federal Register, National Archives and Records Administration, 2009.

DOR Guidelines, *Guidelines for Evaluating Environmental Qualification of Class 1E Electrical Equipment in Operating Reactors,* November 1979.

NRC Regulatory Guide 1.89, Rev. 1, *Environmental Qualification of Certain Electric Equipment Important to Safety for Nuclear Power Plants,* U. S. Nuclear Regulatory Commission, June 1984.

NRC Regulatory Issue Summary 2003-09, *Environmental Qualification of Low-Voltage Instrumentation and Control Cables*, May 2, 2003.

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

CHAPTER XI

AGING MANAGEMENT PROGRAMS (AMPS)

Guidance on Use of Later Editions/Revisions of Various Industry Documents

XI.M1	ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD
XI.M2	Water Chemistry
XI.M3	Reactor Head Closure Stud Bolting
XI.M4	BWR Vessel ID Attachment Welds
XI.M5	BWR Feedwater Nozzle
XI.M6	BWR Control Rod Drive Return Line Nozzle
XI.M7	BWR Stress Corrosion Cracking
XI.M8	BWR Penetrations
XI.M9	BWR Vessel Internals
XI.M10	Boric Acid Corrosion
XI.M11B	Cracking of Nickel-Alloy Components and Loss of Material Due to Boric Acid-Induced Corrosion in Reactor Coolant Pressure Boundary Components (PWRs only)
XI.M12	Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)
XI.M16 A	PWR Vessel Internals
XI.M17	Flow-Accelerated Corrosion
XI.M18	Bolting Integrity
XI.M19	Steam Generators
XI.M20	Open-Cycle Cooling Water System
XI.M21A	Closed Treated Water Systems
XI.M22	Boraflex Monitoring
XI.M23	Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems
XI.M24	Compressed Air Monitoring
XI.M25	BWR Reactor Water Cleanup System
XI.M26	Fire Protection
XI.M27	Fire Water System
XI.M29	Aboveground Metallic Tanks
XI.M30	Fuel Oil Chemistry
XI.M31	Reactor Vessel Surveillance
XI.M32	One-Time Inspection
XI.M33	Selective Leaching
XI.M35	One-Time Inspection of ASME Code Class 1 Small Bore-Piping
XI.M36	External Surfaces Monitoring of Mechanical Components
XI.M37	Flux Thimble Tube Inspection
XI.M38	Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components
XI.M39	Lubricating Oil Analysis
XI.M40	Monitoring of Neutron-Absorbing Materials Other than Boraflex
XI.M41	Buried and Underground Piping and Tanks
XI.S1	ASME Section XI, Subsection IWE
XI.S2	ASME Section XI, Subsection IWL
XI.S3	ASME Section XI, Subsection IWF

GUIDANCE ON USE OF LATER EDITIONS/REVISIONS OF VARIOUS INDUSTRY DOCUMENTS

To aid applicants in the development of their license renewal applications, the staff has developed a list of aging management programs (AMPs) in the GALL Report that are based entirely or in part on specific editions/revisions of various industry codes (other than the ASME Code), standards, and other industry-generated guidance documents. License renewal applicants may use later editions/revisions of these industry generated documents, subject to the following provisions:

(i) If the later edition/revision has been explicitly reviewed and approved/endorsed by the NRC staff for license renewal via an NRC Regulatory Guide endorsement, a safety evaluation for generic use (such as for a BWRVIP), incorporation into 10 CFR, or a license renewal interim staff guidance.

(ii) If the later edition/revision has been explicitly reviewed and approved on a plant-specific basis by the NRC staff in their safety evaluation report for another applicant's license renewal application (a precedent exists). Applicants may reference this and justify applicability to their facility via the exception process in NEI 95-10.

If either of these methods is used as justification for adopting a later edition/revision than specified in the GALL Report, the applicant shall make available for the staff's review the information pertaining to the NRC endorsement/approval of the later edition/revision.

XI.M1 ASME SECTION XI INSERVICE INSPECTION, SUBSECTIONS IWB, IWC, AND IWD

Program Description

Title 10 of the *Code of Federal Regulations*, 10 CFR 50.55a, imposes the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, for Class 1, 2, and 3 pressure-retaining components and their integral attachments in light-water cooled power plants. Inspection of these components is covered in Subsections IWB, IWC, and IWD, respectively, in the 2004 edition.[1] The program generally includes periodic visual, surface, and/or volumetric examination and leakage test of all Class 1, 2, and 3 pressure-retaining components and their integral attachments. Repair/replacement activities for these components are covered in Subsection IWA of the ASME code.

The ASME Section XI inservice inspection program, in accordance with Subsections IWB, IWC, or IWD, has been shown to be generally effective in managing aging effects in Class 1, 2, or 3 components and their integral attachments in light-water cooled power plants. 10 CFR 50.55a imposes additional limitations, modifications, and augmentations of ISI requirements specified in ASME Code, Section XI, and those limitations, modifications, or augmentations described in 10 CFR 50.55a are included as part of this program. In certain cases, the ASME inservice inspection program is to be augmented to manage effects of aging for license renewal and is so identified in the Generic Aging Lessons Learned (GALL) Report.

Evaluation and Technical Basis

1. ***Scope of Program:*** The ASME Section XI program provides the requirements for ISI, repair, and replacement of code Class 1, 2, or 3 pressure-retaining components and their integral attachments in light-water cooled nuclear power plants. The components within the scope of the program are specified in ASME Code, Section XI, Subsections IWB-1100, IWC-1100, and IWD-1100 for Class 1, 2, and 3 components, respectively. The components described in Subsections IWB-1220, IWC-1220, and IWD-1220 are exempt from the volumetric and surface examination requirements, but not exempt from visual exam requirements of Subsections IWB-2500, IWC-2500, and IWD-2500.

2. ***Preventive Actions:*** This is a condition monitoring program. It does not implement preventive actions.

3. ***Parameters Monitored/Inspected:*** The ASME Section XI ISI program detects degradation of components by using the examination and inspection requirements specified in ASME Section XI Tables IWB-2500-1, IWC-2500-1, or IWD-2500-1, respectively, for Class 1, 2, or 3 components.

   The program uses three types of examination—visual, surface, and volumetric—in accordance with the requirements of Subsection IWA-2000. Visual VT-1 examination detects discontinuities and imperfections, such as cracks, corrosion, wear, or erosion, on the surface of components. Visual VT-2 examination detects evidence of leakage from pressure-retaining components, as required during the system pressure test. Visual VT-3 examination (a) determines the general mechanical and structural condition of components and their supports by verifying parameters such as clearances, settings, and physical

[1] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

displacements; (b) detects discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion; and (c) observes conditions that could affect operability or functional adequacy of constant-load and spring-type components and supports.

Surface examination uses magnetic particle, liquid penetrant, or eddy current examinations to indicate the presence of surface discontinuities and flaws.

Volumetric examination uses radiographic, ultrasonic, or eddy current examinations to indicate the presence of discontinuities or flaws throughout the volume of material included in the inspection program.

4. ***Detection of Aging Effects:*** The extent and schedule of the inspection and test techniques prescribed by the program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Inspection can reveal cracking, loss of material due to corrosion, leakage of coolant, and indications of degradation due to wear or stress relaxation (such as changes in clearances, settings, physical displacements, loose or missing parts, debris, wear, erosion, or loss of integrity at bolted or welded connections).

   Components are examined and tested as specified in Tables IWB-2500-1, IWC-2500-1, and IWD-2500-1, respectively, for Class 1, 2, and 3 components. The tables specify the extent and schedule of the inspection and examination methods for the components of the pressure-retaining boundaries. Alternative approved methods that meet the requirements of IWA-2240 are also specified in these tables. For boiling water reactors (BWRs), the nondestructive examination (NDE) techniques appropriate for inspection of vessel internals, including the uncertainties inherent in delivering and executing an NDE technique in a BWR, are included in the approved Boiling Water Reactor Vessel and Internals Project Report (BWRVIP-03).

5. ***Monitoring and Trending:*** For Class 1, 2, or 3 components, the inspection schedule of IWB-2400, IWC-2400, or IWD-2400, respectively, and the extent and frequency of IWB-2500-1, IWC-2500-1, or IWD-2500-1, respectively, provides for timely detection of degradation. The sequence of component examinations established during the first inspection interval is repeated during each successive inspection interval, to the extent practical. If flaw conditions or relevant conditions of degradation are evaluated in accordance with IWB-3100, IWC-3100, or IWD-3000 and the component is qualified as acceptable for continued service, the areas containing such flaw indications and relevant conditions are reexamined during the next three inspection periods of IWB-2410 for Class 1 components, IWC-2410 for Class 2 components, and IWD-2410 for Class 3 components. Examinations that reveal indications that exceed the acceptance standards described below are extended to include additional examinations in accordance with IWB-2430, IWC-2430, or IWD-2430 for Class 1, 2, or, 3 components, respectively.

6. ***Acceptance Criteria:*** Any indication or relevant conditions of degradation are evaluated in accordance with IWB-3000, IWC-3000, or IWD-3000 for Class 1, 2, or 3 components, respectively. Examination results are evaluated in accordance with IWB-3100 or IWC-3100 by comparing the results with the acceptance standards of IWB-3400 and IWB-3500, or IWC-3400 and IWC-3500, respectively, for Class 1 or Class 2 and 3 components. Flaws that exceed the size of allowable flaws, as defined in IWB-3500 or IWC-3500, are evaluated by using the analytical procedures of IWB-3600 or IWC-3600, respectively, for Class 1 or Class

2 and 3 components. Flaws that exceed the size of allowable flaws, as defined in IWB-3500 or IWC-3500, are evaluated by using the analytical procedures of IWB-3600 or IWC-3600, respectively, for Class 1 or Class 2 and 3 components.

7. ***Corrective Actions:*** Repair and replacement activities are performed in conformance with IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** Because the ASME Code is a consensus document that has been widely used over a long period, it has been shown to be generally effective in managing aging effects in Class 1, 2, and 3 components and their integral attachments in light-water cooled power plants (see Chapter I of the GALL Report).

    Some specific examples of operating experience of component degradation are as follows:

    BWR: Cracking due to intergranular stress corrosion cracking (IGSCC) has occurred in small- and large-diameter BWR piping made of austenitic stainless steels and nickel alloys. IGSCC has also occurred in a number of vessel internal components, such as core shrouds, access hole covers, top guides, and core spray spargers (U.S. Nuclear Regulatory Commission [NRC] Bulletin 80-13, NRC Information Notice [IN] 95-17, NRC Generic Letter [GL] 94-03, and NUREG-1544). Cracking due to thermal and mechanical loading has occurred in high-pressure coolant injection piping (NRC IN 89-80) and instrument lines (NRC Licensee Event Report [LER] 50-249/99-003-01). Jet pump BWRs are designed with access holes in the shroud support plate at the bottom of the annulus between the core shroud and the reactor vessel wall. These holes are used for access during construction and are subsequently closed by welding a plate over the hole. Both circumferential (NRC IN 88-03) and radial cracking (NRC IN 92-57) have been observed in access hole covers. Failure of the isolation condenser tube bundles due to thermal fatigue and transgranular stress corrosion cracking (TGSCC) caused by leaky valves has also occurred (NRC LER 50-219/98-014-00).

    PWR Primary System: Although the primary pressure boundary piping of PWRs has generally not been found to be affected by stress corrosion cracking (SCC) because of low dissolved oxygen levels and control of primary water chemistry, SCC has occurred in safety injection lines (NRC IN 97-19 and 84-18), charging pump casing cladding (NRC IN 80-38 and 94-63), instrument nozzles in safety injection tanks (NRC IN 91-05), control rod drive seal housing (NRC Inspection Report 50-255/99012), and safety-related stainless steel (SS) piping systems that contain oxygenated, stagnant, or essentially stagnant borated coolant (NRC IN 97-19). Cracking has occurred in SS baffle former bolts in a number of foreign plants (NRC IN 98-11) and has been observed in plants in the United States. Cracking due to thermal and mechanical loading has occurred in high-pressure injection and safety injection piping (NRC IN 97-46 and NRC Bulletin 88-08). Through-wall circumferential cracking has been found in reactor pressure vessel head control rod drive penetration nozzles (NRC IN 2001-05). Evidence of reactor coolant leakage, together with crack-like indications, has been found in bottom-mounted instrumentation nozzles (NRC IN 2003-11 and IN 2003-11, Supplement 1). Cracking in pressurizer safety and relief line nozzles and in surge line nozzles has been detected (NRC IN 2004-11), and circumferential cracking in stainless steel pressurizer heater sleeves has also been found (NRC IN 2006-27). Also, primary water stress corrosion cracking (PWSCC) has been observed in steam generator drain bowl welds inspected as part of a licensee's Alloy 600/82/182 program (NRC IN 2005-02).

PWR Secondary System: Steam generator tubes have experienced outside diameter stress corrosion cracking (OGSCC), intergranular attack, wastage, and pitting (NRC IN 97-88). Carbon steel support plates in steam generators have experienced general corrosion. Steam generator shells have experienced pitting and stress corrosion cracking (NRC INs 82-37, 85-65, and 90-04).

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

BWRVIP-03, *BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines (EPRI TR-105696 R1, March 30, 1999),* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation for BWRVIP-03, July 15, 1999.

NRC Bulletin 88-08, *Thermal Stresses in Piping Connected to Reactor Coolant System,* U.S. Nuclear Regulatory Commission, June 22, 1988; Supplement 1, June 24, 1988; Supplement 2, September 4, 1988; Supplement 3, April 4, 1989.

NRC Generic Letter 94-03, *Intergranular Stress Corrosion Cracking of Core Shrouds in Boiling Water Reactors*, U.S. Nuclear Regulatory Commission, July 25, 1994.

NRC Bulletin 80-13, *Cracking in Core Spray Spargers*, U.S. Nuclear Regulatory Commission, May 12, 1980.

NRC Information Notice 80-38, *Cracking in Charging Pump Casing Cladding*, U.S. Nuclear Regulatory Commission, October 31, 1980.

NRC Information Notice 82-37, *Cracking in the Upper Shell to Transition Cone Girth Weld of a Steam Generator at an Operating PWR*, U.S. Nuclear Regulatory Commission, September 16, 1982.

NRC Information Notice 84-18, *Stress Corrosion Cracking in PWR Systems*, U.S. Nuclear Regulatory Commission, March 7, 1984.

NRC Information Notice 85-65, *Crack Growth in Steam Generator Girth Welds*, U.S. Nuclear Regulatory Commission, July 31, 1985.

NRC Information Notice 88-03, *Cracks in Shroud Support Access Hole Cover Welds*, U.S. Nuclear Regulatory Commission, February 2, 1988.

NRC Information Notice 89-80, *Potential for Water Hammer, Thermal Stratification, and Steam Binding in High-Pressure Coolant Injection Piping*, U.S. Nuclear Regulatory Commission, December 1, 1989.

NRC Information Notice 90-04, *Cracking of the Upper Shell-to-Transition Cone Girth Welds in Steam Generators*, U.S. Nuclear Regulatory Commission, January 26, 1990.

NRC Information Notice 91-05, *Intergranular Stress Corrosion Cracking in Pressurized Water Reactor Safety Injection Accumulator Nozzles*, U.S. Nuclear Regulatory Commission, January 30, 1991.

NRC Information Notice 92-57, *Radial Cracking of Shroud Support Access Hole Cover Welds*, U.S. Nuclear Regulatory Commission, August 11, 1992.

NRC Information Notice 94-63, *Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks*, U.S. Nuclear Regulatory Commission, August 30, 1994.

NRC Information Notice 95-17, *Reactor Vessel Top Guide and Core Plate Cracking*, U.S. Nuclear Regulatory Commission, March 10, 1995.

NRC Information Notice 97-19, *Safety Injection System Weld Flaw at Sequoyah Nuclear Power Plant, Unit 2*, U.S. Nuclear Regulatory Commission, April 18, 1997.

NRC Information Notice 97-46, *Unisolable Crack in High-Pressure Injection Piping*, U.S. Nuclear Regulatory Commission, July 9, 1997.

NRC Information Notice 97-88, *Experiences During Recent Steam Generator Inspection*s, U.S. Nuclear Regulatory Commission, December 16, 1997.

NRC Information Notice 98-11, *Cracking of Reactor Vessel Internal Baffle Former Bolts in Foreign Plants*, U.S. Nuclear Regulatory Commission, March 25, 1998.

NRC Information Notice 2001-05, *Through-Wall Circumferential Cracking of Reactor Pressure Vessel Head Control Rod Drive Mechanism Penetration Nozzles at Oconee Nuclear Station, Unit 3*, U.S. Nuclear Regulatory Commission, April 30, 2001.

NRC Information Notice 2003-11, *Leakage Found on Bottom-Mounted Instrumentation Nozzles*, U.S. Nuclear Regulatory Commission, August 13, 2003.

NRC Information Notice 2003-11, Supplement 1, *Leakage Found on Bottom-Mounted Instrumentation Nozzles*, U.S. Nuclear Regulatory Commission, January 8, 2004.

NRC Information Notice 2004-11, *Cracking in Pressurizer Safety and Relief Nozzles and in Surge Line Nozzles*, U.S. Nuclear Regulatory Commission, May 4, 2004.

NRC Information Notice 2005-02, *Pressure Boundary Leakage Identified on Steam Generator Drain Bowl Welds*, U.S. Nuclear Regulatory Commission, February 4, 2005.

NRC Information Notice 2006-27, *Circumferential Cracking in the Stainless Steel Pressurizer Heater Sleeves of Pressurized Water Reactors*, U.S. Nuclear Regulatory Commission, December 11, 2006.

NRC Inspection Report 50-255/99012, *Palisades Inspection Report*, Item E8.2, Licensee Event Report 50-255/99-004, *Control Rod Drive Seal Housing Leaks and Crack Indications*, U.S. Nuclear Regulatory Commission, January 12, 2000.

NRC Licensee Event Report LER 50-219/98-014-00, *Failure of the Isolation Condenser Tube Bundles due to Thermal Stresses/Transgranular Stress Corrosion Cracking Caused by Leaky Valve*, U.S. Nuclear Regulatory Commission, October 29, 1998.

NRC Licensee Event Report LER 50-249/99-003-01, *Supplement to Reactor Recirculation B Loop, High Pressure Flow Element Venturi Instrument Line Steam Leakage Results in Unit 3 Shutdown Due to Fatigue Failure of Socket Welded Pipe Joint*, U.S. Nuclear Regulatory Commission, August 30, 1999.

NUREG-1544, *Status Report: Intergranular Stress Corrosion Cracking of BWR Core Shrouds and Other Internal Components*, U.S. Nuclear Regulatory Commission, March 1, 1996.

XI.M2 WATER CHEMISTRY

Program Description

The main objective of this program is to mitigate loss of material due to corrosion, cracking due to stress corrosion cracking (SCC) and related mechanisms, and reduction of heat transfer due to fouling in components exposed to a treated water environment. The program includes periodic monitoring of the treated water in order to minimize loss of material or cracking.

The water chemistry program for boiling water reactors (BWRs) relies on monitoring and control of reactor water chemistry based on industry guidelines contained in the Boiling Water Reactor Vessel and Internals Project (BWRVIP)-190 (Electric Power Research Institute [EPRI] 1016579). The BWRVIP-190 has three sets of guidelines: one for reactor water, one for condensate and feedwater, and one for control rod drive (CRD) mechanism cooling water. The water chemistry program for PWRs relies on monitoring and control of reactor water chemistry based on industry guidelines contained in EPRI 1014986 (PWR Primary Water Chemistry Guidelines-Revision 6) and EPRI 1016555 (PWR Secondary Water Chemistry Guidelines-Revision 7).

The water chemistry programs are generally effective in removing impurities from intermediate and high flow areas. The Generic Aging Lessons Learned (GALL) report identifies those circumstances in which the water chemistry program is to be augmented to manage the effects of aging for license renewal. For example, the water chemistry program may not be effective in low flow or stagnant flow areas. Accordingly, in certain cases as identified in the GALL Report, verification of the effectiveness of the chemistry control program is undertaken to ensure that significant degradation is not occurring and the component’s intended function is maintained during the period of extended operation. For these specific cases, an acceptable verification program is a one-time inspection of selected components at susceptible locations in the system.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program includes components in the reactor coolant system, the engineered safety features, the auxiliary systems, and the steam and power conversion system. This program addresses the metallic components subject to aging management review that are exposed to a treated water environment controlled by the water chemistry program.

2. ***Preventive Actions:*** The program includes specifications for chemical species, impurities and additives, sampling and analysis frequencies, and corrective actions for control of reactor water chemistry. System water chemistry is controlled to minimize contaminant concentration and mitigate loss of material due to general, crevice, and pitting corrosion and cracking caused by SCC. For BWRs, maintaining high water purity reduces susceptibility to SCC, and chemical additive programs such as hydrogen water chemistry, or noble metal chemical application also may be used. For PWRs, additives are used for reactivity control and to control pH and inhibit corrosion.

3. ***Parameters Monitored/Inspected:*** The concentrations of corrosive impurities listed in the EPRI water chemistry guidelines are monitored to mitigate loss of material, cracking, and reduction of heat transfer. Water quality also is maintained in accordance with the guidance. Chemical species and water quality are monitored by in-process methods or through sampling. The chemical integrity of the samples is maintained and verified to ensure that the

method of sampling and storage will not cause a change in the concentration of the chemical species in the samples.

4. ***Detection of Aging Effects:*** This is a mitigation program and does not provide for detection of any aging effects of concern for the components within its scope. The monitoring methods and frequency of water chemistry sampling and testing is performed in accordance with the EPRI water chemistry guidelines and based on plant operating conditions. The main objective of this program is to mitigate loss of material due to corrosion and cracking due to SCC in components exposed to a treated water environment.

5. ***Monitoring and Trending:*** Chemistry parameter data are recorded, evaluated, and trended in accordance with the EPRI water chemistry guidelines.

6. ***Acceptance Criteria:*** Maximum levels for various chemical parameters are maintained within the system-specific limits as indicated by the limits specified in the corresponding EPRI water chemistry guidelines.

7. ***Corrective Actions:*** Any evidence of aging effects or unacceptable water chemistry results are evaluated, the cause identified, and the condition corrected. When measured water chemistry parameters are outside the specified range, corrective actions are taken to bring the parameter back within the acceptable range (or to change the operational mode of the plant) within the time period specified in the EPRI water chemistry guidelines. Whenever corrective actions are taken to address an abnormal chemistry condition, increased sampling or other appropriate actions may be used to verify the effectiveness of these actions. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** Following corrective actions, additional samples are taken and analyzed to verify that the corrective actions were effective in returning the concentrations of contaminants, such as chlorides, fluorides, sulfates, dissolved oxygen, and hydrogen peroxide, to within the acceptable ranges. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process.

9. ***Administrative Controls:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address administrative controls.

10. ***Operating Experience:*** The EPRI guideline documents have been developed based on plant experience and have been shown to be effective over time with their widespread use. The specific examples of operating experience are as follows:

    BWR: Intergranular stress corrosion cracking (IGSCC) has occurred in small- and large-diameter BWR piping made of austenitic stainless steels and nickel-base alloys. Significant cracking has occurred in recirculation, core spray, residual heat removal systems, and reactor water cleanup system piping welds. IGSCC has also occurred in a number of vessel internal components, including core shroud, access hole cover, top guide, and core spray spargers (Nuclear Regulatory Commission [NRC] Bulletin 80-13, NRC Information Notice [IN] 95-17, NRC Generic Letter [GL] 94-03, and NUREG-1544). No occurrence of SCC in piping and other components in standby liquid control systems exposed to sodium pentaborate solution has ever been reported (NUREG/CR-6001).

PWR Primary System: The potential for SCC-type mechanisms might normally occur because of inadvertent introduction of contaminants into the primary coolant system, including contaminants introduced from the free surface of the spent fuel pool (which can be a natural collector of airborne contaminants) or the introduction of oxygen during plant cooldowns (NRC IN 84–18). Ingress of demineralizer resins into the primary system has caused IGSCC of Alloy 600 vessel head penetrations (NRC IN 96-11, NRC GL 97-01). Inadvertent introduction of sodium thiosulfate into the primary system has caused IGSCC of steam generator tubes. SCC has occurred in safety injection lines (NRC INs 97-19 and 84-18), charging pump casing cladding (NRC INs 80-38 and 94-63), instrument nozzles in safety injection tanks (NRC IN 91-05), and safety-related SS piping systems that contain oxygenated, stagnant, or essentially stagnant borated coolant (NRC IN 97-19). Steam generator tubes and plugs and Alloy 600 penetrations have experienced primary water stress corrosion cracking (NRC INs 89-33, 94-87, 97-88, 90-10, and 96-11; NRC Bulletin 89-01 and its two supplements). IGSCC-induced circumferential cracking has occurred in PWR pressurizer heater sleeves (NRC IN 2006-27).

PWR Secondary System: Steam generator tubes have experienced ODSCC, IGA, wastage, and pitting (NRC IN 97-88, NRC GL 95-05). Carbon steel support plates in steam generators have experienced general corrosion. The steam generator shell has experienced pitting and stress corrosion cracking (NRC INs 82-37, 85-65, and 90-04). Extensive buildup of deposits at steam generator tube support holes can result in flow-induced vibrations and tube cracking (NRC IN 2007-37).

Such operating experience has provided feedback to revisions of the EPRI water chemistry guideline documents.

References

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NRC Information Notice 84-18, *Stress Corrosion Cracking in Pressurized Water Reactor Systems*, U.S. Nuclear Regulatory Commission, March 7, 1984.

NRC Information Notice 85-65, *Crack Growth in Steam Generator Girth Welds*, U.S. Nuclear Regulatory Commission, July 31, 1985.

NRC Information Notice 89-33, *Potential Failure of Westinghouse Steam Generator Tube Mechanical Plugs*, U.S. Nuclear Regulatory Commission, March 23, 1989.

NRC Information Notice 90-04, *Cracking of the Upper Shell-to-Transition Cone Girth Welds in Steam Generators*, U.S. Nuclear Regulatory Commission, January 26, 1990.

NRC Information Notice 90-10, *Primary Water Stress Corrosion Cracking (PWSCC) of Inconel 600*, U.S. Nuclear Regulatory Commission, February 23, 1990.

NRC Information Notice 91-05, *Intergranular Stress Corrosion Cracking In Pressurized Water Reactor Safety Injection Accumulator Nozzles*, U.S. Nuclear Regulatory Commission, January 30, 1991.

NRC Information Notice 94-63, *Boric Acid Corrosion of Charging Pump Casing Caused by Cladding Cracks*, U.S. Nuclear Regulatory Commission, August 30, 1994.

NRC Information Notice 94-87, *Unanticipated Crack in a Particular Heat of Alloy 600 Used for Westinghouse Mechanical Plugs for Steam Generator Tubes*, U.S. Nuclear Regulatory Commission, December 22, 1994.

NRC Information Notice 95-17, *Reactor Vessel Top Guide and Core Plate Cracking*, U.S. Nuclear Regulatory Commission, March 10, 1995.

NRC Information Notice 96-11, *Ingress of Demineralizer Resins Increase Potential for Stress Corrosion Cracking of Control Rod Drive Mechanism Penetrations*, U.S. Nuclear Regulatory Commission, February 14, 1996.

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XI.M3 REACTOR HEAD CLOSURE STUD BOLTING

Program Description

This program includes (a) inservice inspection (ISI) in accordance with the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB (2004 edition,[2] no addenda), Table IWB 2500-1; and (b) preventive measures to mitigate cracking. The program also relies on recommendations to address reactor head stud bolting degradation as delineated in NUREG-1339 and Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.65.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program manages the aging effects of cracking due to stress corrosion cracking (SCC) or intergranular stress corrosion cracking (IGSCC) and loss of material due to wear or corrosion for reactor vessel closure stud bolting (studs, washers, bushings, nuts, and threads in flange) for both boiling water reactors (BWRs) and pressurized water reactors (PWRs).

2. ***Preventive Actions:*** Preventive measures include:

   (a) avoiding the use of metal-plated stud bolting to prevent degradation due to corrosion or hydrogen embrittlement;

   (b) using manganese phosphate or other acceptable surface treatments;

   (c) using stable lubricants. Of particular note, use of molybdenum disulfide (MoS_2) as a lubricant has been shown to be a potential contributor to SCC and should not be used (RG 1.65); and

   (d) using bolting material for closure studs that has an actual measured yield strength less than 1,034 megapascals (MPa) (150 kilo-pounds per square inch) (NUREG-1339).

   Implementation of these mitigation measures can reduce potential for SCC or IGSCC, thus making this program effective.

3. ***Parameters Monitored/Inspected:*** The ASME Section XI ISI program detects and sizes cracks, detects loss of material, and detects coolant leakage by following the examination and inspection requirements specified in Table IWB-2500-1.

4. ***Detection of Aging Effects:*** The extent and schedule of the inspection and test techniques prescribed by the program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Inspection can reveal cracking, loss of material due to corrosion or wear, and leakage of coolant.

   The program uses visual, surface, and volumetric examinations in accordance with the general requirements of Subsection IWA-2000. Surface examination uses magnetic particle or liquid penetrant examinations to indicate the presence of surface discontinuities and

[2] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

flaws. Volumetric examination uses radiographic or ultrasonic examinations to indicate the presence of discontinuities or flaws throughout the volume of material. Visual VT-2 examination detects evidence of leakage from pressure-retaining components, as required during the system pressure test.

Components are examined and tested in accordance with ASME Code, Section XI, Table IWB-2500-1, Examination Category B-G-1, for pressure-retaining bolting greater than 2 inches in diameter. Examination Category B-P for all pressure-retaining components specifies visual VT-2 examination of all pressure-retaining boundary components during the system leakage test. Table IWB-2500-1 specifies the extent and frequency of the inspection and examination methods, and IWB-2400 specifies the schedule of the inspection.

5. ***Monitoring and Trending:*** The Inspection schedule of IWB-2400 and the extent and frequency of IWB-2500-1 provide timely detection of cracks, loss of material, and leakage.

6. ***Acceptance Criteria:*** Any indication or relevant condition of degradation in closure stud bolting is evaluated in accordance with IWB-3100 by comparing ISI results with the acceptance standards of IWB-3400 and IWB-3500.

7. ***Corrective Actions:*** Repair and replacement are performed in accordance with the requirements of IWA-4000 and the material and inspection guidance of RG 1.65. The maximum yield strength of replacement material should be limited as recommended in NUREG-1339. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the administrative controls.

10. ***Operating Experience:*** SCC has occurred in BWR pressure vessel head studs (Stoller, 1991). The aging management program has provisions regarding inspection techniques and evaluation, material specifications, corrosion prevention, and other aspects of reactor pressure vessel head stud cracking. Implementation of the program provides reasonable assurance that the effects of cracking due to SCC or IGSCC and loss of material due to wear are adequately managed so that the intended functions of the reactor head closure studs and bolts are maintained consistent with the current licensing basis for the period of extended operation. Degradation of threaded bolting and fasteners in closures for the reactor coolant pressure boundary has occurred from boric acid corrosion, SCC, and fatigue loading (NRC Inspection and Enforcement Bulletin 82-02, NRC Generic Letter 91-17).

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

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XI.M4 BWR VESSEL ID ATTACHMENT WELDS

Program Description

The program includes inspection and flaw evaluation in accordance with the guidelines of a staff-approved boiling water reactor vessel and internals project (BWRVIP-48-A) to provide reasonable assurance of the long-term integrity and safe operation of boiling water reactor (BWR) vessel inside diameter (ID) attachment welds.

The guidelines of BWRVIP-48-A include inspection recommendations and evaluation methodologies for the attachment welds between the vessel wall and vessel ID brackets that attach safety-related components to the vessel (e.g., jet pump riser braces and core spray piping brackets). In some cases, the attachment is a simple weld; in others, it includes a weld build-up pad on the vessel. The BWRVIP-48-A guidelines include information on the geometry of the vessel ID attachments; evaluate susceptible locations and safety consequence of failure; provide recommendations regarding the method, extent, and frequency of inspection; and discuss acceptable methods for evaluating the structural integrity significance of flaws detected during these examinations.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program is focused on managing the effects of cracking due to stress corrosion cracking (SCC), including intergranular stress corrosion cracking (IGSCC). The program is an augmented inservice inspection program that uses the inspection and flaw evaluation criteria in BWRVIP-48-A to detect cracking and monitor the effects of cracking on the intended function of the components. The program provides for repair and/or replacement, as needed, to maintain the ability to perform the intended function. The program is applicable to structural welds for BWR reactor vessel internal integral attachments.

2. ***Preventive Actions:*** The BWR Vessel ID Attachment Welds Program is a condition monitoring program and has no preventive actions. Maintaining high water purity reduces susceptibility to SCC or IGSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation, and technical basis of water chemistry are presented in GALL AMP XI.M2, “Water Chemistry.”

3. ***Parameters Monitored/Inspected:*** The program monitors for cracks induced by SCC and IGSCC on the intended function of BWR vessel ID attachment welds. The program looks for surface discontinuities that may indicate the presence of a crack in the component in accordance with the guidelines of approved BWRVIP-48-A and the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Table IWB 2500-1 (2004 edition[3]).

4. ***Detection of Aging Effects:*** The extent and schedule of the inspection and test techniques prescribed by BWRVIP-48-A guidelines are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function. Inspection can reveal cracking. Vessel ID attachment welds are inspected in accordance with the requirements of ASME Section XI, Subsection IWB, Examination Category B-N-2.

[3] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

The ASME Code, Section XI inspection specifies visual VT-1 examination to detect discontinuities and imperfections on the surfaces of components and visual VT-3 examination to determine the general mechanical and structural condition of the component supports. The inspection and evaluation guidelines of BWRVIP-48-A recommend more stringent inspections for certain attachments. The guidelines recommend enhanced visual VT-1 examination of all safety-related attachments and those non-safety-related attachments identified as being susceptible to IGSCC. Visual VT-1 examination is capable of achieving 1/32-inch resolution; the enhanced visual VT-1 examination method is capable of achieving a 1/2 mil (0.0005 inch) wire resolution. The nondestructive examination (NDE) techniques appropriate for inspection of BWR vessel internals, including the uncertainties inherent in delivering and executing NDE techniques in a BWR, are included in BWRVIP-03.

5. ***Monitoring and Trending:*** Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and approved BWRVIP-48-A guidelines provide timely detection of cracks. If flaws are detected, the scope of examination is expanded. Any indication detected is evaluated in accordance with ASME Code, Section XI or the staff-approved BWRVIP-48-A guidelines. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A documents provide guidelines for evaluation of crack growth in stainless steels, nickel alloys, and low-alloy steels, respectively.

6. ***Acceptance Criteria:*** Acceptance criteria are given in BWRVIP-48-A and ASME Code, Section XI.

7. ***Corrective Actions:*** Repair and replacement procedures are equivalent to those requirements in ASME Code, Section XI. Corrective action is performed in accordance with ASME Code, Section XI, IWA-4000. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the corrective action guidelines in BWRVIP-48-A provides an acceptable level of quality in accordance with 10 CFR Part 50, Appendix B corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-48-A provides an acceptable level of quality in accordance with the 10 CFR Part 50, Appendix B confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** Cracking due to SCC, including IGSCC, has occurred in BWR components. The program guidelines are based on an evaluation of available information, including BWR inspection data and information on the elements that cause IGSCC, to determine which attachment welds may be susceptible to cracking. Implementation of this program provides reasonable assurance that cracking will be adequately managed and that the intended functions of the vessel ID attachments will be maintained consistent with the current licensing basis for the period of extended operation.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

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ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

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BWRVIP-14-A (EPRI 1016569), *Evaluation of Crack Growth in BWR Stainless Steel RPV Internals*, September 2008.

BWRVIP-48-A (EPRI 1009948), *BWR Vessel and Internals Project, Vessel ID Attachment Weld Inspection and Flaw Evaluation Guidelines*, November 2004.

BWRVIP-59-A (EPRI 1014874), *Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals*, May 2007.

BWRVIP-60-A (EPRI 1008871), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Low Alloy Steel RPV Internals*, June 2003.

BWRVIP-62 (EPRI 108705), *BWR Vessel and Internals Project, Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection*, March 7, 2000.

BWRVIP-190 (EPRI 1016579), *BWR Vessel and Internals Project: BWR Water Chemistry Guidelines—2008 Revision*, October 2008.

XI.M5 BWR FEEDWATER NOZZLE

Program Description

This program includes enhanced inservice inspection (ISI) in accordance with (a) the requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, Subsection IWB, Table IWB 2500-1 (2004 edition[4]); (b) the recommendation of General Electric (GE) NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*; and (c) NUREG-0619 recommendations for system modifications to mitigate cracking. The program specifies periodic ultrasonic inspection of critical regions of the boiling water reactor (BWR) feedwater nozzle.

Systems modifications to mitigate cracking may have been made, such as removal of stainless steel cladding and installation of improved spargers. Mitigation also is accomplished by changes to plant-operating procedures, such as improved feedwater control to decrease the magnitude and frequency of temperature fluctuations. These modifications are design and operating changes and were instituted for many BWRs during their initial 40-year operating period.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program includes enhanced ISI to monitor the effects of cracking due to cyclic loading and its impact on the intended function of BWR feedwater nozzles.

2. ***Preventive Actions:*** This program is a condition monitoring program and has no preventive actions.

3. ***Parameters Monitored/Inspected:*** The aging management program (AMP) monitors for cracking due to cyclic loading and its impact on the intended function of the BWR feedwater nozzle by detection and sizing of cracks by ISI in accordance with ASME Code, Section XI, Subsection IWB; the recommendation of GE NE-523-A71-0594, Rev. 1; and NUREG-0619 recommendations.

4. ***Detection of Aging Effects:*** The extent and schedule of the inspection prescribed by the program are designed to ensure that aging effects are discovered and repaired before the loss of intended function of the component. Inspection can reveal cracking.

   GE NE-523-A71-0594, Rev. 1 specifies ultrasonic testing (UT) of specific regions of the blend radius and bore. The UT examination techniques and personnel qualifications are in accordance with the guidelines of GE NE-523-A71-0594, Rev. 1. Based on the inspection method and techniques and plant-specific fracture mechanics assessments, the inspection schedule is in accordance with Table 6-1 of GE NE-523-A71-0594, Rev. 1. Leakage monitoring may be used to modify the inspection interval.

5. ***Monitoring and Trending:*** Inspections scheduled in accordance with GE NE-523-A71-0594, Rev. 1 provide timely detection of cracks.

6. ***Acceptance Criteria:*** Any cracking is evaluated in accordance with ASME Code, Section XI, IWB-3100 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3400 and IWB-3500.

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[4] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

7. ***Corrective Actions:*** Repair and replacement are in conformance with ASME Code, Section XI, Subsection IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** Cracking has occurred in several BWR plants (NUREG-0619, U.S. Nuclear Regulatory Commission [NRC] Generic Letter 81-11). This AMP has been implemented for nearly 30 years and has been found to be effective in managing the effects of cracking on the intended function of feedwater nozzles.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

GE-NE-523-A71-0594, Rev. 1, *Alternate BWR Feedwater Nozzle Inspection Requirements*, BWR Owner's Group, August 1999.

NRC Generic Letter 81-11, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking (NUREG-0619),* U.S. Nuclear Regulatory Commission, February 29, 1981.

NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*, U.S. Nuclear Regulatory Commission, November 1980.

XI.M6 BWR CONTROL ROD DRIVE RETURN LINE NOZZLE

Program Description

This program is a condition monitoring program for boiling water reactor (BWR) control rod drive return line (CRDRL) nozzles that is based on the staff's recommended position in NUREG-0619 for thermal fatigue. This program is also intended to address stress corrosion cracking (SCC) discussed in NRC IN 2004-08. The augmented inspections performed in accordance with the recommendations in NUREG-0619 supplement those in-service inspections that are required for these nozzles in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI, Table IWB-2500-1, as mandated through reference in 10 CFR 50.55a. Thus, this program includes (a) mandatory in-service inspection (ISI) in accordance with the ASME Code, Section XI, Table IWB 2500-1 (2004 edition[5]), and (b) augmented ISI examinations in accordance with applicant's commitments to U.S. Nuclear Regulatory Commission (NRC) Generic Letter (GL) 80-095 to implement the recommendations in NUREG-0619.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program manages the effects of cracking on the intended pressure boundary function of CRDRL nozzles. The scope of this program is applicable to BWRs whose reactor vessel (RV) design includes a welded CRDRL nozzle design. The scope of the program includes CRDRL nozzles and their nozzle-to-RV welds, which are ASME Code Class 1 components. The scope of the program also includes a CRDRL nozzle cap (including any CRDRL nozzle-to-cap welds) if, to mitigate cracking, an applicant has cut the piping to the CRDRL nozzle, and capped the CRDRL nozzle.

2. ***Preventive Actions:*** Activities for preventing or mitigating cracking in CRDRL nozzles are consistent with a BWR facility's past preventive or mitigation actions/activities in its current licensing basis as stated in the applicant's docketed response to NRC GL 80-095 and made to address the recommendations in NUREG-0619. Maintaining high water purity reduces susceptibility to SCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation, and technical basis of water chemistry are addressed through implementation of GALL AMP XI.M2, "Water Chemistry."

3. ***Parameters Monitored/Inspected:*** The aging management program (AMP) manages the effects of cracking on the intended function of the RV, the CRDRL nozzle, and for capped nozzles, the nozzle caps, and cap-to-nozzle welds. For liquid penetrant test (PT) examinations that are implemented in accordance with this AMP, the AMP monitors for linear indications that may be indicative of surface breaking cracks. For the volumetric ultrasonic test (UT) examinations that are performed in accordance with this AMP, the AMP monitors and evaluates signals that may indicate the presence of a planar flaw (crack).

4. ***Detection of Aging Effects:*** The extent and schedule of inspection, as delineated in NUREG-0619, assures detection of cracks before the loss of intended function of the CRDRL nozzles. Inspection and test recommendations include PT of CRDRL nozzle bend radius and bore regions and the RV wall area beneath the nozzle, control rod drive system performance testing, and for capped nozzles, the nozzle caps and cap-to-nozzle welds. The

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[5] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

inspection is to include base metal to a distance of one-pipe-wall thickness or 0.5 inches, whichever is greater, on both sides of the weld.

5. ***Monitoring and Trending:*** The inspection schedule of NUREG-0619 provides timely detection of cracks. Indications of cracking are evaluated and trended in accordance with the ASME Code, Section XI, IWB-3100, against applicable acceptance standard criteria that are specified in the ASME Code, Section XI, IWB-3400 or IWB-3500.

6. ***Acceptance Criteria:*** Any cracking is evaluated in accordance with ASME Code, Section XI, IWB-3100 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3400 and ASME Code, Section XI, IWB-3500.

7. ***Corrective Actions*** Corrective action is performed in conformance with ASME Code, Section XI, IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** Cracking of CRDRL nozzle-to-vessel and nozzle-to-cap welds has occurred in several BWR plants (NUREG-0619 and Information Notice 2004-08). The present AMP has been implemented for nearly 30 years and has been found to be effective in managing the effects of cracking on the intended function of CRDRL nozzles.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards,* Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, The ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

Letter from D. G. Eisenhut, U.S. Nuclear Regulatory Commission, to R. Gridley, General Electric Company, *forwarding NRC Generic Technical Activity A-10*, January 28, 1980.

NRC Generic Letter 80-095, (Untitled), November 13, 1980.[6]

[6] This GL forwarded NUREG-0619 to members of the U.S nuclear power industry and requested that licensees owning BWR model reactors provide confirmation of their intent to implement the recommendations of NUREG-0619, as applied to the design of their BWRs.

NRC Generic Letter 81-11, (Untitled), February 29, 1981.[7]

NRC Information Notice 2004-08, *Reactor Coolant Pressure Boundary Leakage Attributable To Propagation of Cracking In Reactor Vessel Nozzle Welds*, U.S. Nuclear Regulatory Commission, April 22, 2004.

NUREG-0619, *BWR Feedwater Nozzle and Control Rod Drive Return Line Nozzle Cracking*, U.S. Nuclear Regulatory Commission, November 1980.

[7] This GL was issued primarily to provide additional clarification on the contents of the confirmatory response that was requested in NRC GL 80-095.

XI.M7 BWR STRESS CORROSION CRACKING

Program Description

The program to manage intergranular stress corrosion cracking (IGSCC) in boiling water reactor (BWR) coolant pressure boundary piping made of stainless steel (SS) and nickel-based alloy components is delineated in NUREG-0313, Rev. 2, and Nuclear Regulatory Commission (NRC) Generic Letter (GL) 88-01 and its Supplement 1. The material includes base metal and welds. The comprehensive program outlined in NUREG-0313, Rev 2 and NRC GL 88-01 describes improvements that, in combination, will reduce the susceptibility to IGSCC. The elements to cause IGSCC consist of a susceptible (sensitized) material, a significant tensile stress, and an aggressive environment. Sensitization of nonstabilized austenitic stainless steels containing greater than 0.035 weight percent carbon involves precipitation of chromium carbides at the grain boundaries during certain fabrication or welding processes. The formation of carbides creates a chromium-depleted region that, in certain environments, is susceptible to stress corrosion cracking (SCC). Residual tensile stresses are introduced from fabrication processes, such as welding, surface grinding, or forming. High levels of dissolved oxygen or aggressive contaminants, such as sulfates or chlorides, accelerate the SCC processes. The program includes (a) preventive measures to mitigate IGSCC and (b) inspection and flaw evaluation to monitor IGSCC and its effects. The staff-approved boiling water reactor vessel and internals project (BWRVIP-75-A) report allows for modifications to the inspection extent and schedule described in the GL 88-01 program.

Evaluation and Technical Basis

1. ***Scope of Program:*** The program focuses on (a) managing and implementing countermeasures to mitigate IGSCC and (b) performing in-service inspection to monitor IGSCC and its effects on the intended function of BWR piping components within the scope of license renewal. The program is applicable to all BWR piping and piping welds made of austenitic SS and nickel alloy that are 4 inches or larger in nominal diameter containing reactor coolant at a temperature above 93°C (200°F) during power operation, regardless of code classification. The program also applies to pump casings, valve bodies, and reactor vessel attachments and appurtenances, such as head spray and vent components. NUREG-0313, Rev. 2 and NRC GL 88-01, respectively, describe the technical basis and staff guidance regarding mitigation of IGSCC in BWRs. Attachment A of NRC GL 88-01 delineates the staff-approved positions regarding materials, processes, water chemistry, weld overlay reinforcement, partial replacement, stress improvement of cracked welds, clamping devices, crack characterization and repair criteria, inspection methods and personnel, inspection schedules, sample expansion, leakage detection, and reporting requirements.

2. ***Preventive Actions:*** The BWR Stress Corrosion Cracking Program is primarily a condition monitoring program. Maintaining high water purity reduces susceptibility to SCC or IGSCC. Reactor coolant water chemistry is monitored and maintained in accordance with the Water Chemistry Program. The program description, evaluation and technical basis of water chemistry are addressed through implementation of GALL AMP XI.M2, “Water Chemistry.” In addition, NUREG-0313, Rev. 2 and GL 88-01 delineate the guidance for selection of resistant materials and processes that provide resistance to IGSCC such as solution heat treatment and stress improvement processes.

3. ***Parameters Monitored/Inspected:*** The program detects and sizes cracks and detects leakage by using the examination and inspection guidelines delineated in NUREG-0313, Rev. 2, and NRC GL 88-01 or the referenced BWRVIP-75-A guideline as approved by the NRC staff.

4. ***Detection of Aging Effects:*** The extent, method, and schedule of the inspection and test techniques delineated in NRC GL 88-01 or BWRVIP-75-A are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component. Modifications to the extent and schedule of inspection in NRC GL 88-01 are allowed in accordance with the inspection guidance in approved BWRVIP-75-A. The program uses volumetric examinations to detect IGSCC. Inspection can reveal cracking and leakage of coolant. The extent and frequency of inspection recommended by the program are based on the condition of each weld (e.g., whether the weldments were made from IGSCC-resistant material, whether a stress improvement process was applied to a weldment to reduce residual stresses, and how the weld was repaired, if it had been cracked).

5. ***Monitoring and Trending:*** The extent and schedule for inspection, in accordance with the recommendations of NRC GL 88-01 or approved BWRVIP-75-A guidelines, provide timely detection of cracks and leakage of coolant. Indications of cracking are evaluated and trended in accordance with the American Society of Mechanical Engineers (ASME) Code, Section XI, IWA-3000.

   Applicable and approved BWRVIP-14-A, BWRVIP-59-A, BWRVIP-60-A, and BWRVIP-62 reports provide guidelines for evaluation of crack growth in SSs, nickel alloys, and low-alloy steels. An applicant may use BWRVIP-61 guidelines for BWR vessel and internals induction heating stress improvement effectiveness on crack growth in operating plants.

6. ***Acceptance Criteria:*** Any cracking is evaluated in accordance with ASME Code, Section XI, IWA-3000 by comparing inspection results with the acceptance standards of ASME Code, Section XI, IWB-3000, IWC-3000 and IWD-3000 for Class 1, 2 and 3 components, respectively.

7. ***Corrective Actions***: The guidance for weld overlay repair and stress improvement or replacement is provided in NRC GL 88-01. Corrective action is performed in accordance with IWA-4000. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the corrective actions.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the confirmation process and administrative controls.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** Intergranular SCC has occurred in small- and large-diameter BWR piping made of austenitic SS and nickel-base alloys. Cracking has occurred in recirculation, core spray, residual heat removal, CRD return line penetrations, and reactor water cleanup

system piping welds (NRC GL 88-01 and NRC Information Notices [INs] 82-39, 84-41, and 04-08). The comprehensive program outlined in NRC GL 88-01, NUREG-0313, Rev. 2, and in the staff-approved BWRVIP-75-A report addresses mitigating measures for SCC or IGSCC (e.g., susceptible material, significant tensile stress, and an aggressive environment). The GL 88-01 program, with or without the modifications allowed by the staff-approved BWRVIP-75-A report, has been effective in managing IGSCC in BWR reactor coolant pressure-retaining components and will adequately manage IGSCC degradation.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

ASME Code Case N-504-1, *Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping*, Section XI, Division 1, 1995 edition, ASME Boiler and Pressure Vessel Code – Code Cases – Nuclear Components, American Society of Mechanical Engineers, New York, NY.

ASME Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*, ASME Boiler and Pressure Vessel Code, 2004 edition as approved in 10 CFR 50.55a, The American Society of Mechanical Engineers, New York, NY.

BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.

BWRVIP-59-A, (EPRI 1014874), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Nickel-Base Austenitic Alloys in RPV Internals*, Final Report by the Office of Nuclear Reactor Regulation, May 2007.

BWRVIP-60-A (EPRI 108871), *BWR Vessel and Internals Project, Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, June 2003.

BWRVIP-61 (EPRI 112076), *BWR Vessel and Internals Induction Heating Stress Improvement Effectiveness on Crack Growth in Operating Reactors,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, January 29, 1999.

BWRVIP-62 (EPRI 108705), *BWR Vessel and Internals Project, Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, March 7, 2000.

BWRVIP-75-A (EPRI 1012621), *BWR Vessel and Internals Project, Technical Basis for Revisions to Generic Letter 88-01 Inspection Schedules (NUREG-0313),* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, October 2005.

NRC Generic Letter 88-01, *NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping*, U.S. Nuclear Regulatory Commission, January 25, 1988; Supplement 1, February 4, 1992.

NRC Information Notice 04-08, *Reactor Coolant Pressure Boundary Leakage Attributable to Propagation of Cracking in Reactor Vessel Nozzle Welds,* U.S. Nuclear Regulatory Commission, April 22, 2004.

NRC Information Notice 82-39, *Service Degradation of Thick Wall Stainless Steel Recirculation System Piping at a BWR Plant*, U.S. Nuclear Regulatory Commission, September 21, 1982.

NRC Information Notice 84-41, *IGSCC in BWR Plants*, U.S. Nuclear Regulatory Commission, June 1, 1984.

NUREG-0313, Rev. 2, *Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping*, W. S. Hazelton and W. H. Koo, U.S. Nuclear Regulatory Commission, 1988.

XI.M8 BWR PENETRATIONS

Program Description

The program for boiling water reactor (BWR) vessel instrumentation penetrations, control rod drive (CRD) housing and incore-monitoring housing (ICMH) penetrations and standby liquid control (SLC) nozzles/Core ΔP nozzles includes inspection and flaw evaluation in conformance with the guidelines of staff-approved boiling water reactor vessel and internals project (BWRVIP) Topical Reports BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A. The inspection and evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A contain generic guidelines intended to present appropriate inspection recommendations to assure safety function integrity. The guidelines of BWRVIP-49-A provide information on the type of instrument penetration, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-47-A provide information on components located in the lower plenum region of BWRs, evaluate their susceptibility and consequences of failure, and define the inspection strategy to assure safe operation. The guidelines of BWRVIP-27-A are applicable to plants in which the SLC system injects sodium pentaborate into the bottom head region of the vessel (in most plants, as a pipe within a pipe of the core plate ΔP monitoring system). The BWRVIP-27-A guidelines address the region where the ΔP and SLC nozzle or housing penetrates the vessel bottom head and include the safe ends welded to the nozzle or housing. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC line.

Although this is a condition monitoring program, control of water chemistry helps prevent stress corrosion cracking (SCC) and intergranular stress corrosion cracking (IGSCC). The water chemistry program for BWRs relies on monitoring and control of reactor water chemistry based on industry guidelines, such BWRVIP-190 (Electric Power Research Institute [EPRI] 1016579) or later revisions. BWRVIP-190 has three sets of guidelines: one for primary water, one for condensate and feedwater, and one for control rod drive (CRD) mechanism cooling water. Adequate aging management activities for these components provide reasonable assurance that the long-term integrity and safe operation of BWR vessel instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC nozzles/Core ΔP nozzles.

Evaluation and Technical Basis

1. ***Scope of Program:*** The scope of this program is applicable to BWR instrumentation penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles. The program manages cracking due to cyclic loading or SCC and IGSCC using inspection and flaw evaluation in accordance with the guidelines of staff-approved BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A.

2. ***Preventive Actions:*** This program is a condition monitoring program and has no preventive actions. However, maintaining high water purity reduces susceptibility to SCC or IGSCC. The program description, evaluation and technical basis of water chemistry are presented in GALL AMP XI.M2, "Water Chemistry."

3. ***Parameters Monitored/Inspected:*** The program manages the effects of cracking due to SCC/IGSCC on the intended function of the BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations, and BWR SLC nozzles/Core ΔP nozzles. The program accomplishes this by inspection for cracks in accordance with the

guidelines of approved BWRVIP-49-A, BWRVIP-47-A or BWRVIP-27-A and the requirements of the ASME Code, Section XI, Table IWB 2500-1 (2004 edition[8]).

4. ***Detection of Aging Effects:*** The evaluation guidelines of BWRVIP-49-A, BWRVIP-47-A and BWRVIP-27-A provide that the existing inspection requirements in ASME Code, Section XI, Table IWB-2500-1, are sufficient to monitor for indications of cracking in BWR instrumentation nozzles, CRD housing and incore-monitoring housing (ICMH) penetrations and BWR SLC nozzles/Core ΔP nozzles, and should continue to be followed for the period of extended operation. The extent and schedule of the inspection and test techniques prescribed by the ASME Code, Section XI program are designed to maintain structural integrity and ensure that aging effects are discovered and repaired before the loss of intended function of the component.

   Instrument penetrations, CRD housing and incore-monitoring housing (ICMH) penetrations and SLC system nozzles or housings are inspected in accordance with the requirements in the ASME Code, Section XI. These examination categories include volumetric examination methods (ultrasonic testing or radiography testing), surface examination methods (liquid penetrant testing or magnetic particle testing), and VT-2 visual examination methods.

5. ***Monitoring and Trending:*** Inspections scheduled in accordance with ASME Code, Section XI, IWB-2400 and approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A provides timely detection of cracks. The scope of examination and reinspection is expanded beyond the baseline inspection if flaws are detected. Any indication detected is evaluated in accordance with ASME Code, Section XI or other acceptable flaw evaluation criteria, such as the staff-approved BWRVIP-49-A, BWRVIP-47-A, or BWRVIP-27-A guidelines. Applicable and approved BWRVIP-14-A, BWRVIP-59-A, and BWRVIP-60-A documents provide additional guidelines for the evaluation of crack growth in stainless steels (SSs), nickel alloys, and low-alloy steels, respectively.

6. ***Acceptance Criteria:*** Acceptance criteria are given in BWRVIP-49-A for instrumentation nozzles, BWRVIP-47-A for CRD housing and incore-monitoring housing (ICMH) penetrations, and BWRVIP-27A for BWR SLC nozzles/Core ΔP nozzles.

7. ***Corrective Actions:*** Repair and replacement procedures in staff-approved BWRVIP-57-A and BWRVIP-53-A are equivalent to those required in ASME Code, Section XI. Guidelines for repair design criteria are provided in BWRVIP-57-A for instrumentation penetrations and BWRVIP-53-A for SLC line. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27-A provides an acceptable level of quality in accordance with 10 CFR Part 50, Appendix B corrective actions. However, any repair in accordance with ASME Code is acceptable.

8. ***Confirmation Process:*** Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the Appendix for GALL, the staff finds that licensee implementation of the guidelines in BWRVIP-49-A, BWRVIP-47-A, and BWRVIP-27A, as modified, provides an acceptable level of quality for inspection and flaw evaluation of the safety-related components addressed in accordance with the 10 CFR Part 50, Appendix B confirmation process and administrative controls.

[8] Refer to the GALL Report, Chapter I, for applicability of other editions of the ASME Code, Section XI.

9. ***Administrative Controls:*** As discussed in the Appendix for GALL, the staff finds the requirements of 10 CFR Part 50, Appendix B acceptable to address the administrative controls.

10. ***Operating Experience:*** Cracking due to SCC or IGSCC has occurred in BWR components made of austenitic SSs and nickel alloys. The program guidelines are based on an evaluation of available information, including BWR inspection data and information about the elements that cause IGSCC, to determine which locations may be susceptible to cracking. Implementation of the program provides reasonable assurance that cracking will be adequately managed so the intended functions of the instrument penetrations and SLC system nozzles or housings will be maintained consistent with the current licensing basis for the period of extended operation.

References

10 CFR Part 50, Appendix B, *Quality Assurance Criteria for Nuclear Power Plants*, Office of the Federal Register, National Archives and Records Administration, 2009.

10 CFR 50.55a, *Codes and Standards*, Office of the Federal Register, National Archives and Records Administration, 2009.

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BWRVIP-14-A (EPRI 1016569), *BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel RPV Internals,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2008.

BWRVIP-27-A (EPRI 1007279), *BWR Vessel and Internals Project, BWR Standby Liquid Control System/Core Plate ΔP Inspection and Flaw Evaluation Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, August 2003.

BWRVIP-47-A (EPRI 1009947), *BWR Vessel and Internals Project, BWR Lower Plenum Inspection and Flaw Evaluation Guidelines,* Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, November 2004.

BWRVIP-49-A (EPRI 1006602), BWR Vessel and Internals Project, Instrument Penetration Inspection and Flaw Evaluation Guidelines, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation.

BWRVIP-53-A (EPRI 1012120), BWR Vessel and Internals Project, Standby Liquid Control Line Repair Design Criteria Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.

BWRVIP-57-A (EPRI 1012111), BWR Vessel and Internals Project, Instrument Penetration Repair Design Criteria, Final Safety Evaluation Report by the Office of Nuclear Reactor Regulation, September 2005.