CHAPTER V

ENGINEERED SAFETY FEATURES

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MAJOR PLANT SECTIONS

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B. Standby Gas Treatment System (Boiling Water Reactor)

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A. CONTAINMENT SPRAY SYSTEM (PRESSURIZED WATER REACTOR)

A.1 Piping, Fittings and Miscellaneous Items

- A.1.1 Piping and Fittings up to Isolation Valve
- A.1.2 Flow Orifice/Elements
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A.2 Headers and Spray Nozzles

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- A.3.1 Bowl/Casing
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A.4 Valves (Hand, Control, Check, Motor-Operated, and Containment Isolation) in Containment Spray System

- A.4.1 Body and Bonnet
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- A.5.1 Body and Bonnet
- A.5.2 Bolting

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- A.6.3 Shell
- A.6.4 Case/Cover
- A.6.5 Bolting

A. CONTAINMENT SPRAY SYSTEM (PRESSURIZED WATER REACTORS)

Systems, Structures, and Components

This section comprises the containment spray system for pressurized water reactors (PWRs) designed to lower the pressure, temperature, and gaseous radioactivity (iodine) content of the containment atmosphere following a design basis event. Spray systems using chemically treated borated water are reviewed. The system consists of piping and valves, including containment isolation valves, flow elements and orifices, pumps, spray nozzles, eductors, and the containment spray system heat exchanger (some plants).

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 containment spray system outside or inside the containment are governed by Group B Quality Standards.

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

Aging management programs for the degradation of external surfaces of carbon steel components are included in V.E.

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

System Interfaces

The systems that interface with the containment spray system are the PWR emergency core cooling (V.D1), and open- or closed-cycle cooling water systems (VII.C1 or VII.C2).

V Engineered Safety Features

A. Containment Spray System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A.1-a A.1.1 A.1.2 A.1.3	Piping, fittings and miscellaneous items Piping and fittings up to isolation valve Flow orifice/elements Temperature elements/ indicators	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
A.1-b A.1.4	Containment spray system Bolting	Carbon steel, low-alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No
A.1-c A.1.5	Containment spray system Eductors	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
A.2-a A.2.1 A.2.2 A.2.3 A.2.4	Headers and spray nozzles Piping and fittings Flow orifice Headers Spray nozzles	Carbon steel	Air	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
A.3-a A.3.1	Pump Bowl/casing	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
A.3-b A.3.2	Pump Bolting	Carbon steel, low-alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No

V Engineered Safety Features

A. Containment Spray System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A.4-a A.4.1	Valves (hand, control, check, motor-operated, and containment isolation) in containment spray system Body and bonnet	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
A.4-b A.4.2	Valves (hand, control, check, motor-operated, and containment isolation) in containment spray system Bolting	Carbon steel, low-alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No
A.5-a A.5.1	Valves (hand, control and containment isolation) in headers and spray nozzles Body and bonnet	Carbon Steel	Air	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
A.5-b A.5.2	Valves (hand, control and containment isolation) in headers and spray nozzles Bolting	Carbon steel, low-alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No
A.6-a A.6.1 A.6.2 A.6.3 A.6.4	Containment spray heat exchanger (serviced by open-cycle cooling water) Bonnet/cover Tubing Shell Case/cover	Carbon steel, stainless steel	Chemically treated borated water on one side and open-cycle cooling water (raw water) on the other side	Loss of material/ General and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No

V Engineered Safety Features

A. Containment Spray System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A.6-b A.6.2	Containment spray heat exchanger (serviced by open-cycle cooling water) Tubing	Carbon steel, stainless steel	Chemically treated borated water on one side and open-cycle cooling water (raw water) on the other side	Buildup of deposit/ Biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
A.6-c A.6.1 A.6.2 A.6.3 A.6.4	Containment spray heat exchanger (serviced by closed-cycle cooling water) Bonnet/cover Tubing Shell Case/cover	Carbon steel, stainless steel	Chemically treated borated water on tube side and closed-cycle cooling water on shell side	Loss of material/ General, pitting and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
A.6-d A.6.3 A.6.4 A.6.5	Containment spray heat exchanger Shell Case/cover (external surfaces) Bolting	Carbon steel, low-alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No

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B. STANDBY GAS TREATMENT SYSTEM (BOILING WATER REACTOR)

B.1 Ductwork

- B.1.1 Duct, Fittings, Access Doors, and Closure Bolts
- B.1.2 Equipment Frames and Housing
- B.1.3 Seals between Ducts and Fan
- B.1.4 Seals in Dampers and Doors

B.2 Filters

- B.2.1 Housing and Supports
- B.2.2 Elastomer Seals

B. STANDBY GAS TREATMENT SYSTEM (BOILING WATER REACTOR)

Systems, Structures, and Components

This section comprises the standby gas treatment system found in boiling water reactors (BWRs) and consist of ductwork, filters, and fans. 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 standby gas treatment system are governed by Group B Quality Standards.

With respect to charcoal absorber filters, 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 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). The application is to identify the standards that are relied on for replacement as part of the methodology description, for example, NFPA standards for fire protection equipment.

Aging management programs for the degradation of external surfaces of carbon steel components are included in V.E.

System Interfaces

There are no system interfaces with the standby gas treatment system addressed in this section.

V Engineered Safety Features
B. Standby Gas Treatment Systems (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B.1-a B.1.1 B.1.2	Ductwork Fittings, access doors, and closure bolts Equipment frames and housing	Carbon steel	Internal: occasional exposure to moist air; external: ambient plant air environment	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
B.1-b B.1.3 B.1.4	Ductwork Seals between ducts and fan Seals in dampers and doors	Elastomer (Neoprene)	Internal: occasional exposure to moist air; external: ambient plant air environment	Hardening and loss of strength/ Elastomer degradation	A plant-specific aging management program is to be evaluated.	Yes, plant specific
B.2-a B.2.1	Filters Housing and supports	Carbon steel	Internal: occasional exposure to moist air; external: ambient plant air environment	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
B.2-b B.2.2	Filters Elastomer seals	Elastomers (Neoprene and similar materials)	Occasional exposure to moist air	Hardening and loss of strength/ Elastomer degradation	A plant-specific aging management program is to be evaluated.	Yes, plant specific

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C. CONTAINMENT ISOLATION COMPONENTS

C.1 Isolation Barriers

C.1.1 Valve Body and Bonnet
C.1.2 Pipe Penetrations

C. CONTAINMENT ISOLATION COMPONENTS

Systems, Structures, and Components

This section comprises the containment isolation components found in all designs of boiling water reactors (BWR) and pressurized water reactors (PWR) in the United States. The system consists of isolation barriers in lines for BWR and PWR nonsafety systems such as the plant heating, waste gas, plant drain, liquid waste, and cooling water systems. 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 containment isolation components are governed by Group A or B Quality Standards.

The aging management programs for hatchways, hatch doors, penetration sleeves, penetration bellows, seals, gaskets, and anchors are addressed in II.A and II.B. The containment isolation valves for in-scope systems are addressed in the appropriate sections in IV, VII, and VIII.

Aging management programs for the degradation of external surfaces of carbon steel components are included in V.E.

System Interfaces

There are no system interfaces with the containment isolation components addressed in this section.

V Engineered Safety Features
C. Containment Isolation Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
C.1-a C.1.1 C.1.2	BWR and PWR isolation barriers Valve body and bonnet Pipe penetrations (piping between two isolation valves)	Carbon steel and low-alloy steel	Inside surface: treated or raw water, liquid waste; outside surface: ambient air	Loss of material/ General, pitting, crevice and microbiologically influenced corrosion and biofouling	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbiologically influenced corrosion.	Yes, plant specific
C.1-b C.1.1 C.1.2	BWR and PWR isolation barriers Valve body and bonnet Pipe penetrations (piping between two isolation valves)	Stainless steel	Inside surface: treated or raw water, liquid waste; outside surface: ambient air	Loss of material/ Pitting, crevice and microbiologically influenced corrosion and biofouling	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbiologically influenced corrosion.	Yes, plant specific

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D1. EMERGENCY CORE COOLING SYSTEM (PRESSURIZED WATER REACTOR)

D1.1 Piping and Fittings

- D1.1.1 Core Flood System (CFS)
- D1.1.2 Residual Heat Removal (RHR) or Shutdown Cooling (SDC)
- D1.1.3 High-Pressure Safety Injection (HPSI)
- D1.1.4 Low-Pressure Safety Injection (LPSI)
- D1.1.5 Connecting lines to Chemical and Volume Control System (CVCS) and Spent Fuel Pool (SFP) Cooling
- D1.1.6 Lines to Emergency Sump
- D1.1.7 Bolting for Flange Connections

D1.2 HPSI and LPSI Pumps

- D1.2.1 Bowl/Casing
- D1.2.2 Bolting
- D1.2.3 Orifice

D1.3 RWT Circulation Pump

- D1.3.1 Bolting

D1.4 Valves

- D1.4.1 Body and Bonnet
- D1.4.2 Bolting

D1.5 Heat Exchangers (RCP, HPSI, and LPSI Pump Seals; and RHR or SDC)

- D1.5.1 Bonnet/Cover
- D1.5.2 Tubing
- D1.5.3 Shell
- D1.5.4 Case/Cover
- D1.5.5 Bolting

D1.6 Heat Exchangers (RWT Heating)

- D1.6.1 Bonnet/Cover
- D1.6.2 Tubing
- D1.6.3 Shell
- D1.6.4 Bolting

D1.7 Safety Injection Tank (Accumulator)

- D1.7.1 Shell
- D1.7.2 Manway
- D1.7.3 Penetrations/Nozzles

D1.8 Refueling Water Tank (RWT)

D1.8.1 Shell
D1.8.2 Manhole
D1.8.3 Penetrations/Nozzles
D1.8.4 Bolting
D1.8.5 Buried Portion of Tank

D1. EMERGENCY CORE COOLING SYSTEM (PRESSURIZED WATER REACTORS)

Systems, Structures, and Components

This section comprises the emergency core cooling systems for pressurized water reactors (PWRs) designed to cool the reactor core and provide safe shutdown following a design basis accident. They consist of the core flood (CFS), residual heat removal (RHR) (or shutdown cooling (SDC)), high-pressure safety injection (HPSI), low-pressure safety injection (LPSI), and spent fuel pool (SFP) cooling systems; the lines to the chemical and volume control system (CVCS); the emergency sump, the HPSI and LPSI pumps; the pump seal coolers; the RHR heat exchanger; and the refueling water tank (RWT). Stainless steel components are not subject to significant general, pitting, and crevice corrosion in borated water and, therefore, for these stainless steel components, loss of material due to corrosion in borated water is not included in this section.

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 core cooling system are governed by Group B Quality Standards. Portions of the RHR, HPSI, and LPSI systems and the CVCS extending from the reactor coolant system up to and including the second containment isolation valve are governed by Group A Quality Standards and covered in IV.C2.

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

Aging management programs for the degradation of external surfaces of carbon steel components are included in V.E.

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

System Interfaces

The systems that interface with the emergency core cooling system include the reactor coolant system and connected lines (IV.C2), the containment spray system (V.A), the spent fuel pool cooling and cleanup system (VII.A3), the closed-cycle cooling water system (VII.C2), the ultimate heat sink (VII.C3), the chemical and volume control system (VII.E1), and the open-cycle cooling water system (service water system) (VII.C1).

V Engineered Safety Features

D1. Emergency Core Cooling System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D1.1-a D1.1.1 D1.1.2 D1.1.3 D1.1.4 D1.1.5 D1.1.6	Piping and fittings Core flood system Residual heat removal or shutdown cooling High-pressure safety injection Low-pressure safety injection Connecting lines to chemical and volume control system Spent fuel pool cooling lines to emergency sump	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
D1.1-b D1.1.1 D1.1.2 D1.1.3 D1.1.4 D1.1.5 D1.1.6	Piping and fittings Core flood system Residual heat removal or shutdown cooling High-pressure safety injection Low-pressure safety injection Connecting lines to chemical and volume control system Spent fuel pool cooling lines to emergency sump	Cast austenitic stainless steel	Chemically treated borated water at temperature 25–340°C (77-644°F)	Loss of fracture toughness/ Thermal aging embrittlement	Chapter XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)"	No
D1.1-c D1.1.1 D1.1.2 D1.1.3 D1.1.4	Piping and fittings Core flood system Residual heat removal or shutdown cooling High-pressure safety injection Low-pressure safety injection	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA
D1.1-d D1.1.7	Piping and fittings Bolting for flange connections in items D1.1.1 through D1.1.6	Nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No

V Engineered Safety Features
D1. Emergency Core Cooling System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D1.2-a D1.2.1	HPSI and LPSI pumps Bowl/casing	Stainless steel, carbon steel with stainless steel cladding	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
D1.2-b D1.2.1 D1.2.2	HPSI and LPSI pumps Bowl/casing (external surfaces) Bolting	Casing: carbon steel with stainless steel cladding; nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
D1.2-c D1.2.3	HPSI and LPSI pumps Orifice (miniflow recirculation)	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Loss of material/ Erosion	A plant-specific aging management program is to be evaluated for erosion of the orifice due to extended use of the centrifugal HPSI pump for normal charging. See LER 50-275/94-023 for evidence of erosion.	Yes, plant specific
D1.3-a D1.3.1	RWT circulation pump Bolting	Nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
D1.4-a D1.4.1	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet	Stainless steel, carbon steel with stainless steel cladding	Chemically treated borated water at temperature < 93°C (200°F)	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA

V Engineered Safety Features

D1. Emergency Core Cooling System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D1.4-b D1.4.1	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet	Stainless steel, carbon steel with stainless steel cladding	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
D1.4-c D1.4.1 D1.4.2	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet (external surfaces) Bolting	Body and bonnet: carbon steel; nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No
D1.5-a D1.5.1 D1.5.2 D1.5.3 D1.5.4	Heat exchangers (reactor coolant pump seal, HPSI pump seal, LPSI pump seal, RHR or SDC) Bonnet/cover Tubing Shell Case/cover	Bonnet/ cover and tubing: stainless steel; shell: carbon steel; case/cover: cast iron	Chemically treated borated water; and treated component cooling water	Loss of material/ Pitting and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
D1.5-b D1.5.3 D1.5.4 D1.5.5	Heat exchangers (RCP seal, HPSI pump seal, LPSI pump seal, RHR or SDC) Shell Case/cover (external surfaces) Bolting	Shell: carbon steel; case/cover: cast iron; nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No

V Engineered Safety Features

D1. Emergency Core Cooling System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D1.6-a D1.6.1 D1.6.2 D1.6.3	Heat exchanger (RWT heating) serviced by closed-cycle cooling water Bonnet/cover Tubing Shell	Bonnet/ cover and tubing: stainless steel; shell: carbon steel	Chemically treated borated water and treated component cooling water	Loss of material/ Pitting and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
D1.6-b D1.6.1 D1.6.2 D1.6.3	Heat exchanger (RWT Heating) serviced by open-cycle cooling water Bonnet/cover Tubing Shell	Carbon steel, stainless steel	Chemically treated borated water on one side and open-cycle cooling water (raw water) on the other side	Loss of material/ General (carbon steel only), pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
D1.6-c D1.6.2	Heat exchanger (RWT heating) serviced by open-cycle cooling water Tubing	Carbon steel, stainless steel	Chemically treated borated water on one side and open-cycle cooling water (raw water) on the other side	Buildup of deposit/ Biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
D1.6-d D1.6.3 D1.6.4	Heat exchanger (RWT heating) Shell (external surface) Bolting	Shell: carbon steel; nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of Material/ Boric acid corrosion	Chapter XI.M10**, "**Boric Acid Corrosion**"**	No

V Engineered Safety Features
D1. Emergency Core Cooling System (Pressurized Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D1.7-a D1.7.1 D1.7.2 D1.7.3	Safety injection tank (accumulator) Shell Manway Penetrations/ nozzles (all external surface)	Carbon steel with stainless steel cladding	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
D1.7-b D1.7.3	Safety injection tank (accumulator) Penetrations/nozzles	Carbon steel with stainless steel cladding	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
D1.8-a D1.8.1 D1.8.2 D1.8.3	Refueling water tank (RWT) Shell Manhole Penetrations/nozzles	Stainless steel	Chemically treated borated water at temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
D1.8-b D1.8.4	Refueling water tank (RWT) Bolting	Nuts: carbon steel; bolts/studs: alloy steel	Air, leaking chemically treated borated water	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
D1.8-c D1.8.5	Refueling water tank (RWT) Buried portion of tank (outer surface)	Stainless steel	Moisture, water	Loss of material/ Pitting and crevice corrosion	A plant-specific aging management program is to be evaluated for pitting and crevice corrosion of tank bottom because moisture and water can egress under the tank due to cracking of the perimeter seal from weathering.	Yes, plant specific

D2. EMERGENCY CORE COOLING SYSTEM (BWR)

D2.1 Piping and Fittings

- D2.1.1 High Pressure Coolant Injection (HPCI)
- D2.1.2 Reactor Core Isolation Cooling (RCIC)
- D2.1.3 High-Pressure Core Spray (HPCS)
- D2.1.4 Low-Pressure Core Spray (LPCS)
- D2.1.5 Low-Pressure Coolant Injection (LPCI) and Residual Heat Removal (RHR)
- D2.1.6 Lines to Suppression Chamber (SC)
- D2.1.7 Lines to Drywell and Suppression Chamber Spray System (DSCSS)
- D2.1.8 Automatic Depressurization System (ADS)
- D2.1.9 Lines to HPCI and RCIC Pump Turbine
- D2.1.10 Lines from HPCI and RCIC Pump Turbines to Condenser

D2.2 Pumps (HPCS or HPCI Main and Booster, LPCS, LPCI or RHR, and RCIC)

- D2.2.1 Bowl/Casing
- D2.2.2 Suction Head
- D2.2.3 Discharge Head

D2.3 Valves (Check, Control, Hand, Motor Operated, and Relief Valves)

- D2.3.1 Body and Bonnet

D2.4 Heat Exchangers (RHR and LPCI)

- D2.4.1 Tubes
- D2.4.2 Tubesheet
- D2.4.3 Channel Head
- D2.4.4 Shell

D2.5 Drywell and Suppression Chamber Spray System (DSCSS)

- D2.5.1 Piping and Fittings
- D2.5.2 Flow Orifice
- D2.5.3 Headers
- D2.5.4 Spray Nozzles

D2. EMERGENCY CORE COOLING SYSTEM (BOILING WATER REACTORS)

Systems, Structures, and Components

This section comprises the emergency core cooling systems for boiling water reactors (BWRs) designed to cool the reactor core and provide safe shutdown following a design basis accident. They consist of the high-pressure coolant injection (HPCI), reactor core isolation cooling (RCIC), high-pressure core spray (HPCS), automatic depressurization (ADS), low-pressure core spray (LPCS), low-pressure coolant injection (LPCI) and residual heat removal (RHR) systems, including various pumps and valves; the RHR heat exchangers; and the drywell and suppression chamber spray system (DSCSS).

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 core cooling system outside the containment are governed by Group B Quality Standards and the portion of the DSCSS inside the containment up to the isolation valve is governed by Group A Quality Standard. Portions of the HPCI, RCIC, HPCS, LPCS, and LPCI (or RHR) systems extending from the reactor vessel up to and including the second containment isolation valve are governed by Group A Quality Standards and covered in IV.C1.

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

Aging management programs for the degradation of external surfaces of carbon steel components are included in V.E.

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

System Interfaces

The systems that interface with the emergency core cooling system include the reactor vessel (IV.A1), the reactor coolant pressure boundary (IV.C1), the feedwater system (VIII.D2), the condensate system (VIII.E), the closed-cycle cooling water system (VII.C2), the open-cycle cooling water system (VII.C1), and the ultimate heat sink (VII.C3).

V Engineered Safety Features
D2. Emergency Core Cooling system (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D2.1-a D2.1.1 D2.1.2 D2.1.3 D2.1.4 D2.1.5 D2.1.6 D2.1.7	Piping and fittings High-pressure coolant injection Reactor core isolation cooling High-pressure core spray Low-pressure core spray Low-pressure coolant injection and residual heat removal Lines to suppression chamber Lines to drywell and suppression chamber spray system	Carbon steel	25–288°C (77-550°F) demineralized water	Loss of material/ General, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515) The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.	Yes, detection of aging effects is to be evaluated
D2.1-b D2.1.1	Piping and fittings HPCI	Carbon steel, stainless steel	25–288°C (77-550°F) demineralized water	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA
D2.1-c D2.1.1 D2.1.2 D2.1.3 D2.1.4 D2.1.5 D2.1.6 D2.1.7	Piping and fittings HPCI RCIC HPCS LPCS LPCI and RHR Lines to SC Lines to DSCSS	Stainless steel	25–288°C (77-550°F) demineralized water	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking	Chapter XI.M7, "BWR Stress Corrosion Cracking," and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No

V Engineered Safety Features
D2. Emergency Core Cooling system (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D2.1-d D2.1.1 D2.1.2 D2.1.3 D2.1.4 D2.1.5 D2.1.6 D2.1.7	Piping and fittings HPCI RCIC HPCS LPCS LPCI and RHR Lines to SC Lines to DSCSS	Cast austenitic stainless steel	25–288°C (77-550°F) demineralized water	Loss of fracture toughness/ Thermal aging embrittlement	Chapter XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)"	No
D2.1-e D2.1.8	Piping and fittings Automatic depressurization system	Carbon steel, stainless steel	Moist containment atmosphere (air/nitrogen), steam, or demineralized water	Loss of material/ General (carbon steel only), pitting, and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
D2.1-f D2.1.9 D2.1.10	Piping and fittings Lines to HPCI and RCIC pump turbine Lines from HPCI and RCIC pump turbine to torus or wetwell	Carbon steel	Air and steam up to 320°C (608°F)	Wall thinning/ Flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
D2.2-a D2.2.1 D2.2.2 D2.2.3	Pumps HPCS or HPCI main and booster, LPCS, LPCI or RHR, and RCIC Bowl/casing Suction head Discharge head	Carbon steel casting, carbon steel	25–288°C (77-550°F) demineralized water	Loss of material/ General, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515) The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.	Yes, detection of aging effects is to be evaluated
D2.3-a D2.3.1	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet	Carbon steel forging, carbon steel casting	25–288°C (77-550°F) demineralized water	Wall thinning/ Flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No

V Engineered Safety Features
D2. Emergency Core Cooling system (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D2.3-b D2.3.1	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet	Carbon steel forging, carbon steel casting	25–288°C (77-550°F) demineralized water	Loss of material/ General, pitting, and crevice corrosion	Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515) The AMP is to be augmented by verification of its effectiveness of the water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.	Yes, detection of aging effects is to be evaluated
D2.3-c D2.3.1	Valves (check, control, hand, motor operated, and relief valves) Body and bonnet	Stainless steel forging, stainless steel casting	25–288°C (77-550°F) demineralized water	Crack initiation and growth/ Stress corrosion cracking	Chapter XI.M7, "BWR Stress Corrosion Cracking," and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No
D2.4-a D2.4.1 D2.4.2 D2.4.3 D2.4.4	Heat exchangers (RHR and LPCI) (serviced by open-cycle cooling water) Tubes Tubesheet Channel head Shell	Carbon steel, stainless steel	Demineralized water on one side; open-cycle cooling water (raw water) on the other side	Loss of material/ General (carbon steel only), pitting, crevice, and microbiologically influenced corrosion, and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
D2.4-b D2.4.1	Heat exchangers (RHR and LPCI) (serviced by open-cycle cooling water) Tubes	Carbon steel, stainless steel	Demineralized water on one side; open cycle cooling water (raw water) on the other side	Buildup of deposit/ Biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No

V Engineered Safety Features
D2. Emergency Core Cooling system (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
D2.4-c D2.4.1 D2.4.2 D2.4.3 D2.4.4	Heat exchangers (RHR and LPCI) (serviced by closed-cycle cooling water) Tubes Tubesheet Channel head Shell	Carbon steel, stainless steel	Demineralized water on one side; closed-cycle cooling water (treated water) on the other side	Loss of material/ General (carbon steel only), pitting, and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
D2.5-a D2.5.1 D2.5.2 D2.5.3 D2.5.4	Drywell and suppression chamber spray system Piping and fittings Flow orifice Headers Spray nozzles	Carbon steel	Air	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
D2.5-b D2.5.1 D2.5.2 D2.5.3 D2.5.4	Drywell and suppression chamber spray system Piping and fittings Flow orifice Headers Spray nozzles	Carbon steel	Air	Plugging of flow orifice and spray nozzles/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific

E. CARBON STEEL COMPONENTS

E.1 Carbon Steel Components

E.1.1 External Surfaces

E.2 Closure Bolting

E.2.1 In High-Pressure or High-Temperature Systems

E. CARBON STEEL COMPONENTS

Systems, Structures, and Components

This section includes the aging management programs for the degradation of external surface of all carbon steel structures and components including closure boltings in the engineered safety features in pressurized water reactors (PWRs) and boiling water reactors (BWRs). For the carbon steel components in PWRs, this section addresses only boric acid corrosion of external surfaces as a result of the dripping borated water that is leaking from an adjacent PWR component. Boric acid corrosion can also occur for carbon 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 V.

System Interfaces

The structures and components covered in this section belong to the engineered safety features in PWRs and BWRs. (For example, see System Interfaces in V.A to V.D2 for details.)

V Engineered Safety Features
E. Carbon Steel Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E.1-a E.1.1	Carbon steel components (PWRs) External surfaces	Carbon steel, low-alloy steel	Air, leaking and dripping chemically treated borated water up to 340°C (644°F)	Loss of material/ Boric acid corrosion of external surfaces	Chapter XI.M10, "Boric Acid Corrosion"	No
E.1-b E.1.1	Carbon steel components (PWRs and BWRs) External surfaces	Carbon steel, low-alloy steel	Air, moisture, and humidity < 100°C (212°F)	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E.2-a E.2.1	Closure bolting In high-pressure or high-temperature systems	Carbon steel, low-alloy steel	Air, moisture, humidity, and leaking fluid	Loss of material/ General corrosion	Chapter XI.M18, "Bolting Integrity"	No
E.2-b E.2.1	Closure bolting In high-pressure or high-temperature systems	Carbon steel, low-alloy steel	Air, moisture, humidity, and leaking fluid	Crack initiation and growth/ Cyclic loading, stress corrosion cracking	Chapter XI.M18, "Bolting Integrity"	No

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