

# **CHAPTER V**

## **ENGINEERED SAFETY FEATURES**

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## MAJOR PLANT SECTIONS

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- A. Containment Spray System (Pressurized Water Reactor)
- B. Standby Gas Treatment System (Boiling Water Reactor)
- C. Containment Isolation Components
- D1. Emergency Core Cooling System (Pressurized Water Reactor)
- D2. Emergency Core Cooling System (Boiling Water Reactor)
- E. Carbon Steel Components

*(refined outline to be added when issued for public comment)*

**Explanation of September 30, 2004 changes in preliminary interim draft chapter outline and aging management review (AMR) tables:** Within the AMR tables, this update process increases license renewal review efficiency by:

- Consolidating components (combining similar or equivalent components with matching materials, environment and AMP into a single line-item),
- Increasing consistency between **Material/Environment/Aging effects/aging management Program (MEAP)** combinations between systems (some existing MEAPs had multiple definitions that, based on the aging effect, could be broadened to envelope these into a single MEAP),
- Correcting any inconsistencies in the 2001 edition of the GALL Report,
- Updating references to the appropriate aging management programs, and
- Incorporating line-item changes based on approved staff SER positions or interim staff guidance.

The principal effect of this change is that the tables present the MEAP combinations at a higher level, and the prior detail within a structure or component line item is no longer explicitly presented. Consequently, the identifiers for subcomponents within a line item are no longer presented in the tables. As a result, the introductory listings of these subcomponents (originally in text preceding each table) have been deleted.

The following AMR tables contain a revised "Item" column and a new column titled "Link", which was not contained in the July 2001 revision. The "Item" number is a unique identifier that is used for traceability and, as mentioned above, no longer presents the detailed subcomponent identification. The link identifies the original item in the current version of the GALL Report when applicable (items added to this list refer to bases statements not yet available).

By January 30, 2005, the NRC staff plans to issue a revised GALL Report (NUREG-1801) and SRP-LR (NUREG-1800) for public comment. NRC anticipates re-numbering the line-

items to provide an improved unique identifier as part of the public comment document. Also as part of the public comment process, the NRC will issue a NUREG documenting the basis for the proposed changes to the GALL Report and the SRP-LR. This NUREG bases document will be an aid for those reviewing the revised documents to understand what was changed and the basis for the proposed changes.

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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~~
- ~~A.1.3 Temperature Elements/Indicators~~
- ~~A.1.4 Bolting~~
- ~~A.1.5 Eductors~~

### ~~A.2 Headers and Spray Nozzles~~

- ~~A.2.1 Piping and Fittings~~
- ~~A.2.2 Flow Orifice~~
- ~~A.2.3 Headers~~
- ~~A.2.4 Spray Nozzles~~

### ~~A.3 Pumps~~

- ~~A.3.1 Bowl/Casing~~
- ~~A.3.2 Bolting~~

### ~~A.4 Valves (Hand, Control, Check, Motor Operated, and Containment Isolation) in Containment Spray System~~

- ~~A.4.1 Body and Bonnet~~
- ~~A.4.2 Bolting~~

### ~~A.5 Valves (Hand, Control, and Containment Isolation) in Headers and Spray Nozzles~~

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

### ~~A.6 Containment Spray Heat Exchanger~~

- ~~A.6.1 Bonnet/Cover~~
- ~~A.6.2 Tubing~~
- ~~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 components and miscellaneous bolting are included in V.E. Common miscellaneous material environment combinations where there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation are included in V.F.

~~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 A							
ENGINEERED SAFETY FEATURES Containment Spray System (PWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-26	V.A.2-a V.A.5-a	Ducting, piping and components external surfaces	Steel	Air – indoor uncontrolled (External)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-28	V.A.6-d V.A.5-b V.A.3-b V.A.4-b V.A.1-b	External surfaces	Steel	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
E-43	V.A.	Heat exchanger shell	Gray cast iron	Treated water	Loss of material/ Selective leaching	Chapter XI.M33, “Selective Leaching of Material”	No
E-17	V.A.6-c	Heat exchanger shell side components	Steel	Closed cycle cooling water	Macrofouling and loss of material/ general, pitting and crevice corrosion	Chapter XI.M21, “Closed-Cycle Cooling Water System”	No
E-19	V.A.6-c	Heat exchanger shell side components including tubes	Stainless steel	Closed cycle cooling water	Loss of material/ pitting and crevice corrosion	Chapter XI.M21, “Closed-Cycle Cooling Water System”	No
E-20	V.A.6-a	Heat exchanger shell side components including tubes	Stainless steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, “Open-Cycle Cooling Water System”	No



V A ENGINEERED SAFETY FEATURES Containment Spray System (PWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-18	V.A.6-a	Heat exchanger shell side components including tubes	Steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
EP-13	EP-13	Heat exchanger tubes	Copper alloy <15% Zn	Closed cycle cooling water	Loss of material/ pitting, crevice corrosion and galvanic corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
E-21	V.A.6-b	Heat exchanger tubes (serviced by open-cycle cooling water)	Stainless steel	Raw water	Reduction of heat transfer/ biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
E-29	V.A.5-a V.A.2-a	Piping and components internal surfaces	Steel	Air – indoor uncontrolled (Internal)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
EP-2	EP-2	Piping, piping components, and piping elements	Aluminum	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No 1
E-12	V.A.3-a V.A.4-a V.A.1-a V.A.1-c	Piping, piping components, piping elements, and tanks	Stainless steel	Treated borated water >60°C (>140°F)	Cracking/ stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	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 components and miscellaneous bolting are included in V.E. Common miscellaneous material environment combinations where there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation are included in V.F.

~~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 B ENGINEERED SAFETY FEATURES Standby Gas Treatment System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-40	V.B.1-a	Ducting closure Bolting	Steel	Air – indoor uncontrolled (External)	Loss of material/ general, pitting and crevice corrosion	A plant-specific aging management program is to be evaluated	Yes, plant specific
E-26	V.B.1-a V.B.2-a	Ducting, piping and components external surfaces	Steel	Air – indoor uncontrolled (External)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-25	V.B.2-a	Ducting, piping and components internal surfaces	Steel	Air – indoor uncontrolled (Internal)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-05	V.B.1-b	Elastomer seals	Elastomers	Air – indoor uncontrolled (External)	Hardening and loss of strength/ elastomer degradation	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-06	V.B.2-b V.B.1-b	Elastomer seals	Elastomers	Air – indoor uncontrolled >35°C (>95°F) (Internal/External)	Hardening and loss of strength/ elastomer degradation	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-42	V.B.	Piping, piping components, and piping elements	Steel	Soil	Loss of material/ general, pitting and crevice corrosion	Chapter XI.M28, “Buried Piping and Tanks Surveillance,”  Or  Chapter XI.M34, “Buried Piping and Tanks Inspection”	No   Yes, detection of aging effects and operating experience are to be further evaluated

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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 components and miscellaneous bolting are included in V.E. Common miscellaneous material environment combinations where there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation are included in V.F.

~~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 C ENGINEERED SAFETY FEATURES Containment Isolation Components							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-35	V.C.1-a	Containment isolation piping and components external surfaces	Steel	Air – indoor uncontrolled (External)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-32	V.C.1-a	Containment isolation piping and components external surfaces	Steel	Untreated water	Loss of material/ general, pitting, crevice corrosion, and microbologically influenced corrosion	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbologically influenced corrosion.	Yes, plant specific
E-36	V.C.1-b	Containment isolation piping and components internal surfaces	Stainless steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice and microbologically influenced corrosion	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbologically influenced corrosion.	Yes, plant specific
E-33	V.C.1-b	Containment isolation piping and components internal surfaces	Stainless steel	Treated water	Loss of material/ pitting and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-34	V.C.1-b	Containment isolation piping and components internal surfaces	Stainless steel	Untreated water	Macrofouling and loss of material/ pitting, crevice and microbologically influenced corrosion	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbologically influenced corrosion.	Yes, plant specific

V C ENGINEERED SAFETY FEATURES Containment Isolation Components							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-30	V.C.1-a	Containment isolation piping and components internal surfaces	Steel	Condensation (External)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-22	V.C.1-a	Containment isolation piping and components internal surfaces	Steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice and microbiologically influenced corrosion	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbiologically influenced corrosion.	Yes, plant specific
E-31	V.C.1-a	Containment isolation piping and components internal surfaces	Steel	Treated water	Loss of material/ general, pitting and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
EP-2	EP-2	Piping, piping components, and piping elements	Aluminum	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No 1

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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 components and miscellaneous bolting are included in V.E. Common miscellaneous material environment combinations where there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation are included in V.F.](#)

[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 D1 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (PWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-28	V.D1.6-d V.D1.2-b V.D1.4-c V.D1.5-b V.D1.7-a V.D1.1-d V.D1.3-a V.D1.8-b	External surfaces	Steel	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
E-43	V.D1.	Heat exchanger shell	Gray cast iron	Treated water	Loss of material/ Selective leaching	Chapter XI.M33, "Selective Leaching of Material"	No
E-17	V.D1.6-a V.D1.5-a	Heat exchanger shell side components	Steel	Closed cycle cooling water	Macrofouling and loss of material/ general, pitting and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
E-19	V.D1.5-a V.D1.6-a	Heat exchanger shell side components including tubes	Stainless steel	Closed cycle cooling water	Loss of material/ pitting and crevice corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
E-20	V.D1.6-b	Heat exchanger shell side components including tubes	Stainless steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No

V D1 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (PWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-18	V.D1.6-b	Heat exchanger shell side components including tubes	Steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
EP-13	EP-13	Heat exchanger tubes	Copper alloy <15% Zn	Closed cycle cooling water	Loss of material/ pitting, crevice corrosion and galvanic corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
E-21	V.D1.6-c	Heat exchanger tubes (serviced by open-cycle cooling water)	Stainless steel	Raw water	Reduction of heat transfer/ biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
E-24	V.D1.2-c	Orifice (miniflow recirculation)	Stainless steel	Treated borated water	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
E-01	V.D1.8-c	Partially encased tanks with breached moisture barrier	Stainless steel	Untreated water or raw 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



V D1 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (PWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
EP-2	EP-2	Piping, piping components, and piping elements	Aluminum	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No 1
E-11	V.D1.1-b	Piping, piping components, and piping elements	Cast austenitic stainless steel	Treated borated water >250°C (>482°F)	Loss of fracture toughness/ thermal aging embrittlement	Chapter XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)"	No
E-13	V.D1.1-c V.D1.4-a	Piping, piping components, and piping elements	Stainless steel	Treated borated water	Cumulative fatigue damage	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
E-12	V.D1.4-b V.D1.2-a V.D1.8-a V.D1.7-b V.D1.1-a	Piping, piping components, piping elements, and tanks	Stainless steel	Treated borated water >60°C (>140°F)	Cracking/ stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No
E-39	V.D1.7-a	Safety injection tank (accumulator)	Steel with stainless steel cladding	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
E-38	V.D1.7-b	Safety injection tank (accumulator)	Steel with stainless steel cladding	Treated borated water >60°C (>140°F)	Cracking/ stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No

## ~~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). **Auxiliary area ventilation system includes RCIC, HPCI, RHR, and core spray pump room cooling.**

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 components and miscellaneous bolting are included in V.E. Common miscellaneous material environment combinations where there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation are included in V.F.**  
~~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 D2 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-04	V.D2.5-b	Drywell and suppression chamber spray system (internal surfaces: Flow orifice Spray nozzles	Steel	Air – indoor uncontrolled (Internal)	Macrofouling and loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-26	V.D2.1-e V.D2.5-a	Ducting, piping and components external surfaces	Steel	Air – indoor uncontrolled (External)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-17	V.D2.4-c	Heat exchanger shell side components	Steel	Closed cycle cooling water	Macrofouling and loss of material/ general, pitting and crevice corrosion	Chapter XI.M21, “Closed-Cycle Cooling Water System”	No
E-19	V.D2.4-c	Heat exchanger shell side components including tubes	Stainless steel	Closed cycle cooling water	Loss of material/ pitting and crevice corrosion	Chapter XI.M21, “Closed-Cycle Cooling Water System”	No

V D2 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-20	V.D2.4-a	Heat exchanger shell side components including tubes	Stainless steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
E-18	V.D2.4-a	Heat exchanger shell side components including tubes	Steel	Raw water	Macrofouling and loss of material/ general, pitting, crevice, and microbiologically influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
EP-13	EP-13	Heat exchanger tubes	Copper alloy <15% Zn	Closed cycle cooling water	Loss of material/ pitting, crevice corrosion and galvanic corrosion	Chapter XI.M21, "Closed-Cycle Cooling Water System"	No
E-21	V.D2.4-b	Heat exchanger tubes (serviced by open-cycle cooling water)	Stainless steel	Raw water	Reduction of heat transfer/ biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No
E-23	V.D2.4-b	Heat exchanger tubes (serviced by open-cycle cooling water)	Steel	Raw water	Reduction of heat transfer/ biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System"	No

V D2 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-29	V.D2.5-a	Piping and components internal surfaces	Steel	Air – indoor uncontrolled (Internal)	Loss of material/ general corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-27	V.D2.1-e	Piping and components internal surfaces	Steel	Condensation (Internal)	Loss of material/ general, pitting and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-11	V.D2.1-d	Piping, piping components, and piping elements	Cast austenitic stainless steel	Treated borated water >250°C (>482°F)	Loss of fracture toughness/ thermal aging embrittlement	Chapter XI.M12, “Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)”	No
E-16	V.D2.1-b	Piping, piping components, and piping elements	Stainless steel	Treated water	Cumulative fatigue damage	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
E-37	V.D2.1-c	Piping, piping components, and piping elements	Stainless steel	Treated water >60°C (>140°F)	Cracking/ stress corrosion cracking and intergranular stress corrosion cracking	Chapter XI.M2, “Water Chemistry,” for BWR water in BWRVIP-29 (EPRI TR-103515)	No
E-07	V.D2.1-f	Piping, piping components, and piping elements	Steel	Air and steam	Loss of material/ flow-accelerated corrosion	Chapter XI.M17, “Flow-Accelerated Corrosion”	No

V D2 ENGINEERED SAFETY FEATURES Emergency Core Cooling System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-10	V.D2.1-b	Piping, piping components, and piping elements	Steel	Treated water	Cumulative fatigue damage	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
E-09	V.D2.3-a	Piping, piping components, and piping elements	Steel	Treated water	Loss of material/ flow-accelerated corrosion	Chapter XI.M17, "Flow-Accelerated Corrosion"	No
E-08	V.D2.2-a V.D2.3-b V.D2.1-a	Piping, piping components, and piping elements	Steel	Treated 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
E-14	V.D2.1-e	Piping, piping components, and piping elements internal surfaces	Stainless steel	Condensation (Internal/External)	Loss of material/ pitting and crevice corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific

V ENGINEERED SAFETY FEATURES							
D2 Emergency Core Cooling System (BWR)							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
E-15	V.D2.3-c	Piping, piping components, and piping elements with 4 inch and larger nominal diameter	Stainless steel	Raw water	Cracking/ 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
E-12	V.D2.1-c V.D2.3-c	Piping, piping components, piping elements, and tanks	Stainless steel	Treated borated water >60°C (>140°F)	Cracking/ stress corrosion cracking	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714	No



**E. EXTERNAL SURFACES OF COMPONENTS AND MISCELLANEOUS BOLTING**  
**~~CARBON STEEL COMPONENTS AND MISCELLANEOUS BOLTING~~**

**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 E							
ENGINEERED SAFETY FEATURES							
External Surfaces of Components and Miscellaneous Bolting							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
EP-1	EP-1	Bolting	Steel	Air – outdoor (External)	Loss of material/ general, pitting and crevice corrosion	Chapter XI.18, “Bolting Integrity”	No
E-41	V.E.	Bolting	Steel	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
E-03	V.E.2-b	Closure bolting	High strength steel	Air with steam or water leakage	Cracking/ cyclic loading, stress corrosion cracking	Chapter XI.M18, “Bolting Integrity”	No
EP-24	EP-24	Closure bolting	Steel	Air – indoor uncontrolled (External)	Loss of preload/ stress relaxation	Chapter XI.M18, “Bolting Integrity,”	No
EP-25	EP-25	Closure bolting	Steel	Air – indoor uncontrolled (External)	Loss of material/ general, pitting and crevice corrosion	Chapter XI.M.18, “Bolting Integrity”	No
E-02	V.E.2-a	Closure bolting	Steel	Air with steam or water leakage	Loss of material/ general, pitting and crevice corrosion	Chapter XI.M18, “Bolting Integrity”	No
E-44	V.E.	External surfaces	Steel	Air – indoor uncontrolled (External)	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-45	V.E.	External surfaces	Steel	Air – outdoor (External)	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific
E-28	V.E.1-a	External surfaces	Steel	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No
E-46	V.E.	External surfaces	Steel	Condensation (External)	Loss of material/ General corrosion	A plant-specific aging management program is to be evaluated.	Yes, plant specific

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## **F. 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 emergency safety feature system's structures and components. For the material-environment combinations in this part, there are no aging effects which are expected to degrade the ability of the structure or component from performing its intended function for the extended period of operation, and, 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 engineered safety features in PWRs and BWRs. (For example, see System Interfaces in V.A to V.D2 for details.)

V F							
ENGINEERED SAFETY FEATURES Common Miscellaneous Material Environment Combinations							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
EP-14	EP-14	Ducting	Galvanized steel	Air – indoor uncontrolled (External)	None	None	No
EP-3	EP-3	Piping, piping components, and piping elements	Aluminum	Air – indoor uncontrolled (Internal/External)	None	None	No
EP-2	EP-2	Piping, piping components, and piping elements	Aluminum	Air with borated water leakage	Loss of material/ boric acid corrosion	Chapter XI.M10, “Boric Acid Corrosion”	No 1
EP-8	EP-8	Piping, piping components, and piping elements	Cast austenitic stainless steel	Air – indoor uncontrolled (External)	None	None	No
EP-10	EP-10	Piping, piping components, and piping elements	Copper alloy	Air – indoor uncontrolled (External)	None	None	No
EP-9	EP-9	Piping, piping components, and piping elements	Copper alloy	Gas	None	None	No
EP-11	EP-11	Piping, piping components, and piping elements	Copper alloy	Lubricating oil (no water pooling)	None	None	No

V ENGINEERED SAFETY FEATURES							
F Common Miscellaneous Material Environment Combinations							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
EP-12	EP-12	Piping, piping components, and piping elements	Copper alloy <15% Zn	Air with borated water leakage	None	None	No
EP-15	EP-15	Piping, piping components, and piping elements	Glass	Air – indoor uncontrolled (External)	None	None	No
EP-16	EP-16	Piping, piping components, and piping elements	Glass	Lubricating oil	None	None	No
EP-17	EP-17	Piping, piping components, and piping elements	Nickel alloy	Air – indoor uncontrolled (External)	None	None	No
EP-18	EP-18	Piping, piping components, and piping elements	Stainless steel	Air – indoor uncontrolled (External)	None	None	No
EP-19	EP-19	Piping, piping components, and piping elements	Stainless steel	Air with borated water leakage	None	None	No
EP-20	EP-20	Piping, piping components, and piping elements	Stainless steel	Concrete	None	None	No

V F							
ENGINEERED SAFETY FEATURES Common Miscellaneous Material Environment Combinations							
Item	Link	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
EP-22	EP-22	Piping, piping components, and piping elements	Stainless steel	Gas	None	None	No
EP-21	EP-21	Piping, piping components, and piping elements	Stainless steel	Lubricating oil	None	None	No
EP-4	EP-4	Piping, piping components, and piping elements	Steel	Air – indoor controlled (External)	None	None	No
EP-5	EP-5	Piping, piping components, and piping elements	Steel	Concrete	None	None	No
EP-7	EP-7	Piping, piping components, and piping elements	Steel	Gas	None	None	No
EP-6	EP-6	Piping, piping components, and piping elements	Steel	Lubricating oil (no water pooling)	None	None	No
EP-23	EP-23	Piping, piping components, and piping elements internal surfaces	Stainless steel	Treated borated water	None	None	No

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