3.3 AGING MANAGEMENT OF AUXILIARY SYSTEMS

The following systems are evaluated as part of the auxiliary systems:

- Refueling equipment system
- Shutdown cooling system (Dresden only)
- Control rod drive hydraulic system
- Reactor water cleanup system
- Fire protection system
- Emergency diesel generator and auxiliaries
- HVAC-Main control room
- HVAC-Reactor building
- ECCS corner room HVAC
- Station blackout building HVAC
- Station blackout system (diesels and auxiliaries)
- Diesel generator cooling water system
- Diesel fuel oil system
- Process sampling system
- Carbon dioxide system
- Service water system
- Reactor building closed cooling water system
- Turbine closed cooling water system (in-scope Dresden only)
- Residual heat removal service water system (Quad Cities only)
- Containment cooling service water system (Dresden only)
- Ultimate heat sink
- Fuel pool cooling and filter demineralizer system (in-scope for Dresden only)
- Plant heating system
- Containment atmosphere monitoring system
- Nitrogen containment atmosphere dilution system
- Drywell nitrogen inerting system
- Safe shutdown makeup pump system (Quad Cities only)
- Standby liquid control system
- Cranes and hoists
- Demineralized water makeup system

<u>Components Evaluated Consistent with NUREG-1801</u>

The components or component groups requiring aging management review in each of the auxiliary systems listed above are presented in Chapter 2. Aging management reviews were performed to assure that the component groups, materials, environments and aging effects referenced in NUREG-1801 are applicable to Dresden and Quad Cities and that the aging management program described in NUREG-1801 is appropriate.

When the components or component group and associated evaluations corresponded with an individual line item in NUREG-1801, Volume 2, the component aging management results were included in the appropriate line items in Table 3.3-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems" for auxiliary systems. Each line in Table 3.3-1 matches a line in Chapter 3 of NUREG-1800, that is applicable to Boiling Water Reactors (BWR) or to both Boiling Water Reactors and Pressurized Water Reactors (BWR/ PWR).

Not all component types in the Dresden and Quad Cities Auxiliary Systems are listed in NUREG-1801, Volume 2. However, the aging management reviews presented in NUREG-1801, Volume 2 were applied to additional component types if the following criteria were satisfied:

- Constructed of the same material as components in the NUREG-1801 line item,
- Assigned the same Component Intended Function as components in the NUREG-1801 line item,
- Located in the same environment as components in the NUREG-1801 line item, and
- Have exhibited the same aging effects identified in the NUREG-1801 line item.

Component types meeting these criteria have been included in the presentation of aging management review results in Table 3.3-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems." The third column of the table shows the component types included in each evaluation line. "NUREG-1801 Components" are those that correspond exactly with component types in NUREG-1801, Volume 2. "Evaluated with NUREG-1801 Components" shows the component types that meet the four (4) criteria above, and therefore share the same evaluation characteristics. Dresden and Quad Cities do not have all of the component types identified in NUREG-1801, Volume 2. The component type entries in the third column of Table 3.3-1 under the "NUREG-1801 Components" heading are those components or component groups that were identified and evaluated at Dresden and Quad Cities.

Other Components Evaluated

Table 3.3-2 "Aging management review results for the auxiliary systems that are not addressed in NUREG-1801" presents the aging management review results for the remainder of the auxiliary systems components. These entries result from aging management review results where the component type, material, environment or aging effect/mechanism differs from NUREG-1801, Volume 2 line item entries. Each line in Table 3.3-2 includes a line reference number, component group, material, environment, aging effect/mechanism, aging management program and discussion.

3.3.1 Aging management programs evaluated in NUREG-1801 that are relied upon for license renewal for the auxiliary systems

Table 3.3-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems" shows the component groups and aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.1	Components in spent fuel pool cooling and cleanup	NUREG-1801 Components Piping and Fittings	Loss of material due to general, pitting, and crevice corrosion	Water chemistry (B.1.2) and one-time inspection (B.1.23)	Yes, detection of aging effects is to be further evaluated	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2. Further evaluation of Loss of Material due to General, Pitting, and Crevice Corrosion is described in Section 3.3.1.1.1. Components evaluated in NUREG-1801 lines VII.A4.2-a, 3-a, 4-b, 5-a and 6-a are not in the scope of license renewal. Only Dresden has these components in the scope of license renewal.
3.3.1.2	Linings in spent fuel pool cooling and cleanup system; seals and collars in ventilation systems	NUREG-1801 Components Flex Collars, Doors and Damper Seals Seals	Hardening, cracking and loss of strength due to elastomer degradation; loss of material due to wear	Plant specific	Yes, plant specific	Further evaluation of Hardening and Cracking or Loss of Strength due to Elastomer Degradation or Loss of Material due to Wear is described in Section 3.3.1.1.5. Elastomer linings of valves for water systems evaluated in NUREG-1801, line VII.A4, are not within the scope of license renewal. Elastomers are not in the scope of license renewal for ECCS room coolers at Dresden and Quad Cities.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.3	Components in load handling, chemical and volume control system (PWR), and reactor water cleanup and shutdown cooling systems (older BWR)	NUREG-1801 Components Cranes Piping and Fittings	Cumulative fatigue damage	TLAA, evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further Evaluation of cumulative fatigue damage is provided in Section 3.3.1.1.6, Section 4.3.3.2(piping) and Section 4.7.1 (crane).
3.3.1.4	Heat exchangers in reactor water cleanup system (BWR); high pressure pumps in chemical and volume control system (PWR)	See Discussion Column	Crack initiation and growth due to SCC or cracking	Plant specific	Yes, plant specific	Components are not in the scope of license renewal

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.5	Components in ventilation systems, diesel fuel oil system, and emergency diesel generator systems; external surfaces of carbon steel components	NUREG-1801 Components Air Accumulator Vessels Air Handlers Heating/ Cooling (CR HVAC) Carbon Steel Components Doors, Closure Bolts, Equip Frames Ducts & Fittings, Access Doors, Closure Bolts, Equip Frames Filters/ Strainers Housings and Supports Mufflers Piping and Fittings Evaluated with NUREG-1801 Components Dampeners, Filters/ Strainers, Flame Arrestors, Lubricators, Pumps, Valves, Heat Exchangers, Restricting Orifices, Orifice Bodies, Sight Glasses, Sprinklers, Tanks, Strainer bodies, Thermowells, Tubing, Diffusers, Flow Elements Traps	Loss of material due to general, pitting, and crevice corrosion, and MIC	Plant specific	Yes, plant specific	Further evaluation of Loss of Material due to General, Microbiologically Influenced, Pitting, and Crevice Corrosion is described in Section 3.3.1.1.7. The primary containment heating and cooling coils evaluated in NUREG-1801, line VII.F3.2-a are not within the scope of license renewal. Dresden and Quad Cities do not have diesel fuel oil system valves or pumps, identified in NUREG-1801, lines VII.H1.2 and VII.H1.3, located outdoors. Dresden and Quad Cities do not have material-environment combination evaluated in NUREG-1801 lines VII.F1.2-a, VII.F2.2-a, VII.F2.4-a, VII.F4.2-a. Filter housing and supports identified in NUREG-1801, line VII.F2.4-a are not included in Dresden and Quad Cities auxiliary and radwaste area ventilation systems.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.6	Components in reactor coolant pump oil collect system of fire protection	See Discussion Column	Loss of material due to galvanic, general, pitting, and crevice corrosion	One-time inspection (B.1.23)	Yes, detection of aging effects is to be further evaluated	Lube oil components for Dresden and Quad Cities are addressed as non NUREG-1801 lines.
3.3.1.7	Diesel fuel oil tanks in diesel fuel oil system and emergency diesel generator system	NUREG-1801 Components Tanks Evaluated with NUREG-1801 Components Filters/ Strainers Piping and Fittings Pumps Thermowells Valves	Loss of material due to general, pitting, and crevice corrosion, MIC, and biofouling	Fuel oil chemistry (B.1.21) and one-time inspection (B.1.23)	Yes, detection of aging effects is to be further evaluated	Consistent with NUREG-1801, with exception. The exceptions to Fuel Oil Chemistry are described in Section B.1.21. Further evaluation of Loss of Material due to General, Pitting, Crevice, and Microbiologically Influenced Corrosion and Biofouling is described in Section 3.3.1.1.8.
3.3.1.8	Piping, pump casing, and valve body and bonnets in shutdown cooling system (older BWR)	NUREG-1801 Components Piping and Fittings Pumps Evaluated with NUREG-1801 Components Dampeners Filters/ Strainers Flow Elements Restricting Orifices Sight Glasses Tanks Thermowells Tubing Valves	Loss of material due to pitting and crevice corrosion	Water chemistry (B.1.2) and one-time inspection (B.1.23)	Yes, detection of aging effects is to be further evaluated	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2. Further evaluation of Loss of Material due to General, Pitting, and Crevice Corrosion is described in Section 3.3.1.1.2.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.9	Neutron absorbing sheets in spent fuel storage racks	NUREG-1801 Components Neutron-Absorbing Sheets	Reduction of neutron absorbing capacity and loss of material due to general corrosion (Boral, boron steel)	Plant specific	Yes, plant specific	Further evaluation of Reduction of Neutron-Absorbing Capacity and Loss of Material due to General Corrosion is described in Section 3.3.1.1.3. Boral is used only at Dresden.
3.3.1.10	New fuel rack assembly	See Discussion Column	Loss of material due to general, pitting, and crevice corrosion	Structures monitoring (B.1.30)	No	The new fuel racks at Dresden and Quad Cities are not made of carbon steel. ThereforeNUREG-1801, line VII.A1.1-a, does not apply.
3.3.1.11	Spent fuel storage racks and valves in spent fuel pool cooling and cleanup	NUREG-1801 Components Storage Racks	Crack initiation and growth due to stress corrosion cracking	Water chemistry (B.1.2)	No	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2.
3.3.1.12	Neutron absorbing sheets in spent fuel storage racks	NUREG-1801 Components Neutron-Absorbing Sheets	Reduction of neutron absorbing capacity due to Boraflex degradation	Boraflex monitoring (B.1.36)	No	Consistent with NUREG-1801. Boraflex is used only at Quad Cities.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.13	Components in or serviced by closed-cycle cooling water system	NUREG-1801 Components Orifice Bodies Piping and Fittings Pumps Tanks Valves Evaluated with NUREG-1801 Components Manifolds Piping and Fittings Pumps Tanks Thermowells Tubing Valves	Loss of material due to general, pitting, and crevice corrosion, and MIC	Closed-cycle cooling water system (B.1.14)	No	Consistent with NUREG-1801. The fuel pool cooling heat exchangers identified in NUREG-1801, line VII.A4.4 are not in the scope of license renewal. The reactor water cleanup system non-regenerative heat exchangers identified in NUREG-1801, line VII.E3.4 are not in the scope of license renewal. The control room, auxiliary and radwaste , primary containment, and diesel generator building HVAC systems identified in NUREG-1801, lines VII.F1.3-a, VII.F2.3-a, VII.F3.3-a, and VII.F4.3-a do not include hot or cold chemically treated water environments. Only Dresden has components in the scope of license renewal that apply to this line item.
3.3.1.14	Cranes including bridge and trolleys and rail system in load handling system	NUREG-1801 Components Cranes Evaluated with NUREG-1801 Components Rails	Loss of material due to general corrosion and wear	Overhead heavy load and light load handling systems (B.1.15)	No	Consistent with NUREG-1801, with exception. The exceptions to Inspection of Overhead Heavy Load and Light Load (Related to Refueling) Handling Systems are described in Section B.1.15.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.15	Components in or serviced by open-cycle cooling water systems	NUREG-1801 Components Orifice Bodies Piping and Fittings Pumps Strainer Bodies Valves Evaluated with NUREG-1801 Components Dampeners Flow Elements Flow Orifices Pulsation Dampeners Sight Glasses Strainer Screens Thermowells Tubes Tubing	Loss of material due to general, pitting, crevice, and galvanic corrosion, MIC, and biofouling; buildup of deposit due to biofouling	Open-cycle cooling water system (B.1.13)	No	Consistent with NUREG-1801, with exception. The exceptions to biofouling for a(2) components are described in Section 3.3.1.2.2. The exceptions to Open-Cycle Cooling Water System are described in Section B.1.13. Dresden and Quad Cities do not have material-environment combination evaluated in NUREG-1801 lines VII.C1.3-a and VII.C1.3-b. NUREG-1801, line VII.C3.2-a does not apply to valve material at Dresden. Quad Cities does not have any ultimate heat sink valves in the scope of license renewal. Brass and bronze instrument pulsation dampeners are only used at Quad Cities. Only Quad Cities heat exchangers use this material/environment combination.
3.3.1.16	Buried piping and fittings	NUREG-1801 Components Piping and Fittings	Loss of material due to general, pitting, and crevice corrosion, and MIC	Buried piping and tanks surveillance or Buried piping and tanks inspection (B.1.25)	No Yes, detection of aging effects and operating experience are to be further evaluated	Consistent with NUREG-1801, with exception. The exceptions to Buried Piping and Tanks Inspection are described in Section B.1.25. Further evaluation of Loss of Material due to General, Pitting, Crevice, and Microbiologically Influenced Corrosion is described in Section 3.3.1.1.4.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.17	Components in compressed air system	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Filters/ Strainers Tubing	Loss of material due to general and pitting corrosion	Compressed air monitoring (B.1.16)	No	Consistent with NUREG-1801, with exception. The exceptions to Compressed Air Monitoring are described in Section B.1.16. The instrument air system components evaluated in NUREG-1801, lines VII.D.3-a, 4-a, 5-a, and 6-a are not within the scope of license renewal.
3.3.1.18	Components (doors and barrier penetration seals) and concrete structures in fire protection	NUREG-1801 Components Doors Fire Doors Penetration Seals Evaluated with NUREG-1801 Components Fire dampers	Loss of material due to wear; hardening and shrinkage due to weathering	Fire protection (B.1.18)	No	Consistent with NUREG-1801, with exception. The exceptions to Fire Protection are described in Section B.1.18. Elastomers are not in the scope of license renewal for Intake structures (crib house) at Dresden and Quad Cities. Primary containment does not contain fire doors as identified in NUREG-1801, line VII.G.5-c.
3.3.1.19	Components in water-based fire protection	NUREG-1801 Components Filters/ Strainers Fire Hydrants Piping and Fittings Pumps Sprinklers Valves	Loss of material due to general, pitting, crevice, and galvanic corrosion, MIC, and biofouling	Fire water system (B.1.19)	No	Consistent with NUREG-1801, with exception. The exceptions to Fire Water System are described in Section B.1.19.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.20	Components in diesel fire system	NUREG-1801 Components Piping and Fittings Evaluated with NUREG-1801 Components Filters/ Strainers Tanks Valves	Loss of material due to galvanic, general, pitting, and crevice corrosion	Fire protection (B.1.18) and fuel oil chemistry (B.1.21)	No	Consistent with NUREG-1801, with exception. The exceptions to Fire Protection are described in Section B.1.18. The exceptions to Fuel Oil Chemistry are described in Section B.1.21.
3.3.1.21	Tanks in diesel fuel oil system	See Discussion Column	Loss of material due to general, pitting, and crevice corrosion	Aboveground carbon steel tanks (B.1.20)	No	There are no aboveground carbon steel tanks in the diesel fuel oil system
3.3.1.22	Closure bolting	NUREG-1801 Components Closure Bolting	Loss of material due to general corrosion; crack initiation and growth due to cyclic loading and SCC	Bolting integrity (B.1.12)	No	Consistent with NUREG-1801, with exception. The exceptions to Bolting Integrity are described in Section B.1.12.
3.3.1.23	Components in contact with sodium penta-borate solution in standby liquid control system (BWR)	NUREG-1801 Components Piping and Fittings Pumps Tanks Valves Evaluated with NUREG-1801 Components Dampeners Thermowells Tubing	Crack initiation and growth due to SCC	Water chemistry (B.1.2)	No	Consistent with NUREG-1801, with exception. The exceptions to the application of the water chemistry program are described in Section 3.3.1.2.3. The exceptions to Water Chemistry are described in Section B.1.2.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.24	Components in reactor water cleanup system	NUREG-1801 Components Piping and Fittings	Crack initiation and growth due to SCC and IGSCC	Reactor water cleanup system inspection (B.1.17)	No	Consistent with NUREG-1801, with exception. The exceptions to BWR Reactor Water Cleanup System are described in Section B.1.17. The RWCU pumps identified in NUREG-1801, lines VII.E3.2-a, b, and c are not in the scope of license renewal.
3.3.1.25	Components in shutdown cooling system (older BWR)	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Dampeners Filters/ Strainers Flow Elements Pumps Restricting Orifices Tubing	Crack initiation and growth due to SCC	BWR stress corrosion cracking (B.1.7) and water chemistry (B.1.2)	No	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2. The exceptions to BWR Stress Corrosion Cracking are described in Section B.1.7.
3.3.1.26	Components in shutdown cooling system (older BWR)	NUREG-1801 Components Heat Exchangers	Loss of material due to pitting and crevice corrosion, and MIC	Closed-cycle cooling water system (B.1.14)	No	Consistent with NUREG-1801. Only Dresden heat exchangers use this material/ environment combination.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.27	Components (aluminum bronze, brass, cast iron, cast steel) in open-cycle and closed-cycle cooling water systems, and ultimate heat sink	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Dampeners	Loss of material due to selective leaching	Selective leaching of materials (B.1.24)	No	Consistent with NUREG-1801, with exception. The exceptions to Selective Leaching of Materials are described in Section B.1.24. Brass or copper-nickel identified in NUREG-1801 line VII.C3.1-a (piping) and 3.2-a (valves) are not used in ultimate heat sink piping at Dresden or Quad Cities. Components in NUREG-1801 item VIIC1.1-c (buried cast iron components) are managed for selective leaching rather than general corrosion. Dresden and Quad Cities do not have material-environment combination evaluated in NUREG-1801 lines VII.C1.3-a. Dresden and Quad Cities pump and piping material is carbon steel in the open-cycle cooling water system, as discussed in NUREG-1801, lines VII.C1.5-a and VII.C3.1-a, and is therefore not susceptible to selective leaching. Dresden and Quad Cities pump material is carbon steel in the closed-cycle cooling water system, as discussed in NUREG-1801, lines VII.C2.3-a, and is therefore not susceptible to selective leaching. Brass and bronze instrument pulsation dampeners are only used at Quad Cities.

Table 3.3-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the auxiliary systems (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.3.1.28	Fire barriers, walls, ceilings and floors in fire protection	NUREG-1801 Components Walls, Ceilings, Floors Evaluated with NUREG-1801 Components Concrete Manholes Concrete Shield Plugs	Concrete cracking and spalling due to freeze-thaw, aggressive chemical attack, and reaction with aggregates; loss of material due to corrosion of embedded steel	Fire protection (B.1.18) and structures monitoring (B.1.30)	No	Consistent with NUREG-1801, with exception. The exceptions to structural aging effects due to aggressive chemical attack, reaction with aggregates, freeze-thaw & corrosion of embedded steel are described in Section 3.3.1.2.1. The exceptions to Fire Protection are described in Section B.1.18.

3.3.1.1 Further Evaluation of aging management as recommended by NUREG-1801 for the auxiliary systems

3.3.1.1.1 Loss of Material due to General, Pitting, and Crevice Corrosion (NUREG-1800, Section 3.3.2.2.1.1)

To confirm the effectiveness of aging management program Water Chemistry (B.1.2), a one-time inspection of the Dresden fuel pool cooling and filter demineralizer system will be performed. The one-time inspection will be either a visual or ultrasonic examination of a stainless steel component or piping in the system. The inspection will inspect for general, pitting, and crevice corrosion.

3.3.1.1.2 Loss of Material due to General, Pitting, and Crevice Corrosion (NUREG-1800, Section 3.3.2.2.1.2)

An inspection of selected components exposed to a stagnant flow water environment will be conducted in accordance with aging management program One-Time Inspection (B.1.23.) The inspection of selected components will verify the effectiveness of the chemistry control program to manage loss of material due to general, pitting, and crevice corrosion in low flow or stagnant flow areas by ensuring that significant degradation is not occurring and the component intended function will be maintained during the extended period of operation. Examinations will be conducted on carbon and stainless steel components in areas where typically stagnant flow is present but occasionally there is flow, which will cause replenishment of the oxygen supply. Inspections will be conducted on the HPCI torus suction check valves, the HPCI booster pumps, and the control rod drive (CRD) scram valves. These components were selected to provide representative samples of the aging effects seen in the shutdown cooling system. The carbon steel HPCI torus suction check valves are exposed to torus water while the carbon steel HPCI booster pumps and the stainless steel CRD scram valves are exposed to condensate storage tank water. Both will undergo a visual exam. This inspection is also credited for those components exposed to reactor coolant, which are outside NUREG-1801, line IV.C1.

3.3.1.1.3 Reduction of Neutron-Absorbing Capacity and Loss of Material due to General Corrosion (NUREG-1800, Section 3.3.2.2.10)

Reduction of neutron-absorbing capacity and loss of material due to general corrosion could occur at Dresden, in the boral neutron absorbing material in the spent fuel storage racks. Aging management program Water Chemistry (B.1.2) manages general corrosion. A one-time inspection of boral coupon test specimens at Dresden has been performed. The one-time inspection confirmed that significant aging degradation has not occurred and that neutron absorbing capability has not been reduced.

3.3.1.1.4 Loss of Material due to General, Pitting, Crevice, and Microbiologically Influenced Corrosion (NUREG-1800, Section 3.3.2.2.11)

Aging management program Buried Piping and Tanks Inspection (B.1.25) relies on industry practice, frequency of pipe excavations, and operating experience to manage the aging of buried components. Since Dresden and Quad Cities infrequently expose buried components during yard excavation activities, additional testing and inspection activities are credited. Specific aging management activities for buried components include:

1) Preventive measures (coatings and wrappings) to mitigate corrosion,

2) Periodic inspections of buried piping and tanks whenever they are excavated during yard area excavations (Structures Monitoring),

3) Periodic pressure testing of buried Class 3 cooling water piping,

4) Periodic pressure testing of buried Fire Mains,

5) Periodic inspection of the inside of buried fuel oil storage tanks (including 'one-time' ultrasonic test),

6) 'One-time' tank bottom ultrasonic test of an outdoor aluminum tank on an earthen foundation,

7) Periodic inspection of the ground above buried commodities for seepage and settling, and

8) 'One-time' excavation and inspection of a section of fire main piping if Item 2) doesn't occur prior to year 39.

3.3.1.1.5 Hardening and Cracking or Loss of Strength due to Elastomer Degradation or Loss of Material due to Wear (NUREG-1800, Section 3.3.2.2.2)

Aging management of control room, emergency diesel generator building, station blackout diesel generator building, and reactor building (using the requirements of the containment ventilation) ventilation system elastomers will be performed by the periodic inspection of elastomers in accordance with plant-specific aging management program Periodic Inspection of Ventilation System Elastomers (B.2.3.)

3.3.1.1.6 Cumulative Fatigue Damage (NUREG-1800, Section 3.3.2.2.3)

Cumulative fatigue damage of auxiliary system piping and load handling cranes is a TLAA as defined in 10 CFR 54.3. RWCU pumps identified by NUREG-1801 lines VII E3.2-b and VII E3.2-c are not in the scope of license renewal and are not evaluated as a TLAA. Cumulative fatigue damage of auxiliary system piping and load handling cranes is required to be evaluated in accordance with 10 CFR 54.21(c)(1). The TLAA evaluation of auxiliary system piping outside the RCPB is addressed in Section 4.3.3.2. The TLAA evaluation of load handling cranes is addressed in Section 4.7.1.

3.3.1.1.7 Loss of Material due to General, Microbiologically Influenced, Pitting, and Crevice Corrosion (NUREG-1800, Section 3.3.2.2.5)

Emergency diesel generator and station blackout diesel fuel oil piping external surface aging management in outdoor ambient conditions will be managed with system engineer walkdowns performed by Bolting Integrity (B.1.12) and Buried Piping and Tanks Inspection (B.1.25) aging management programs.

Emergency diesel generator and station blackout diesel auxiliaries, diesel generator cooling water, diesel fuel oil, shutdown cooling water (Dresden only), reactor water cleanup, process sampling, standby liquid control, control rod drive hydraulic system, fire protection (fire water portions), service water, ultimate heat sink, reactor building closed cooling water, turbine building closed cooling water (Dresden only), fuel pool cooling and filter demineralizer system (Dresden only), residual heat removal service water (Quad Cities only), containment cooling service water (Dresden only), plant heating system, drywell nitrogen inerting, demineralized water makeup, and safe shutdown makeup pump system (Quad Cities only) components external surface in a sheltered environment with warm, moist air will be managed either by the Structures Monitoring Program (B.1.30) or system engineer walkdowns performed by Bolting Integrity (B.1.12), and Structures Monitoring Program (B.1.30) aging management activities.

A visual inspection of selected components will be performed in accordance with the requirements of the Fire Protection (B.1.18) aging management program to verify the integrity of halon system (Dresden only), cardox system, and fire protection diesel-driven fire pump fuel oil subsystem external surfaces in a sheltered environment with warm, moist air.

Emergency diesel generator and station blackout diesel combustion air, and exhaust air, diesel fuel oil, drywell nitrogen inerting (nitrogen storage tank and outdoor components), and nitrogen containment atmosphere dilution external surface aging management of components in outdoor ambient conditions will be managed with system engineer walkdowns performed by Bolting Integrity (B.1.12). Emergency diesel generator and station blackout diesel combustion air, starting air, and exhaust air interior air environments will be managed with a One-Time Inspection (B.1.23) of compressed gas systems.

Air handler cooling coils for main control room HVAC, reactor building HVAC, SBO building HVAC (includes cooler frames and housings), and ECCS room cooler HVAC (includes cooler frames and housings) will be managed with Open-Cycle Cooling Water System (B.1.13) or Heat Exchanger Test and Inspection Activities (B.2.6) aging management programs depending on the cooling fluid environment. Other ventilation system metallic components, including equipment frames and housings, within the scope of license renewal for main control room HVAC, reactor building HVAC, and SBO building HVAC (with exception of cooler frames and housing), and emergency diesel generator HVAC will be managed with a One-Time Inspection (B.1.23) of the ventilation systems.

Components Requiring Aging Management for Loss of Material Due to General Corrosion

	Aging Management Program						
	Buried Piping and Tanks Inspection (B.1.25)	Bolting Integrity (B.1.12)	Structural Monitoring (B.1.30)	Fire Protection (B.1.18)	One-Time Inspection: Compressed Gas (B.1.23)	One-Time Inspection: Ventilation Systems (B.1.23)	Air Handler Cooling Coil AMPs (See Note 1)
Air Accumulator Vessels					X		
Air Handler Heating/Cooling Coils							X
Carbon Steel Components (See Note 2)		X	X	X			
Doors, Closure Bolts, Equipment Frames						X	X
Filter/Strainers					X		
Flame Arrestors					X		
Housing and Supports						X	
Lubricators					X		
Mufflers					X		
Piping and Fittings	X	X			X		
Pumps					X		
Valves					X		

Notes

1. Air handler cooling coil aging management programs include:
   - Open-Cycle Cooling Water (B.1.13)
   - Heat Exchanger Testing & Inspection (B.2.6)

2 Carbon Steel Components include: diffusers, filter/strainers, flow elements, heat exchangers, lubricators, piping & fittings, pumps, restricting orifices, sight glasses, sprinklers, tanks, thermowells, traps, tubing, and valves.

3.3.1.1.8 Loss of Material due to General, Pitting, Crevice, and Microbiologically Influenced Corrosion and Biofouling (NUREG-1800, Section 3.3.2.2.7)

An inspection will be performed in accordance with aging management program One-Time Inspection (B.1.23) to verify the effectiveness of Fuel Oil Chemistry (B.1.21) aging management program at preventing loss of material. An UT examination of the lower portion of one carbon steel underground fuel oil storage tank and one day tank at each facility will be performed. The Quad Cities Unit I underground fuel oil storage tank is constructed of fiberglass and aging management for loss of material is discussed separately as a non-NUREG-1801 item.

Activities to prevent biofouling of the fuel oil systems are performed in accordance with aging management program Fuel Oil Chemistry (B.1.21). Preventive activities include routine sampling to provide assurance that contaminant levels, including water, are kept at acceptable levels for fuel oil system components, and the addition of a biocide to the underground fuel oil storage tanks with each new fuel delivery.

3.3.1.2 Aging management programs or evaluations that are different than those described in NUREG-1801

3.3.1.2.1 Exception to structural aging effects due to aggressive chemical attack, reaction with aggregates, freeze-thaw & corrosion of embedded steel

Structures Monitoring Program (B.1.30) and Fire Protection (B.1.18) are required to manage the structural aging effects for concrete in accessible areas. No aging management is required to manage the following structural aging effects for concrete in inaccessible areas.

- Cracking and spalling due to aggressive chemical attack

Dresden and Quad Cities ground water test data obtained during construction, the 1980's, 1990's, and 2000's shows that the below-grade environment is not aggressive based on NUREG-1801 criteria with chlorides less than 500 ppm, sulfates less than 1500 ppm, and pH greater than 5.5. Examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of aging management program Structures Monitoring Program (B.1.30.) To ensure conditions are maintained throughout the period of extended operations, aging management program Structures Monitoring Program (B.1.30) will be enhanced to include monitoring of below-grade water chemistry to demonstrate that the environment remains non-aggressive. Existing plant procedures will be used to periodically sample pH, chlorides, and sulfates.

- Cracking and spalling due to reaction with aggregates

Dresden and Quad Cities documented evidence demonstrates that the concrete used meets the requirements of ACI 201.2R-77 with no evidence of reactive aggregates. Therefore, concrete cracking and spalling due to reaction with aggregates in inaccessible areas are not applicable and no aging management is required.

- Cracking and spalling due to freeze-thaw

Dresden and Quad Cities are located in severe weathering conditions. Dresden and Quad Cities have documented evidence to show that the concrete air content is between 3% and 6%. Plant inspections did not show freeze-thaw degradation. Therefore, concrete cracking and spalling due to freeze-thaw in inaccessible areas are not applicable and no aging management is required.

- Loss of material due to corrosion of embedded steel

Dresden and Quad Cities ground water test data obtained during construction, the 1980's, 1990's, and 2000's shows that the below-grade environment is not aggressive based on NUREG-1801 criteria with chlorides less than 500 ppm, sulfates less than 1500 ppm, and pH greater than 5.5. Examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of aging management program Structures Monitoring Program (B.1.30.) To ensure conditions are maintained throughout the period of extended operations, aging management program Structures Monitoring Program (B.1.30) will be enhanced to include monitoring of below-grade water chemistry to demonstrate that the environment remains non-aggressive. Existing plant procedures will be used to periodically sample pH, chlorides, and sulfates.

3.3.1.2.2 Exception to biofouling for a(2) components

Biofouling of components included in scope for criteria a(2) in a raw water environment does not require aging management to maintain the component intended function.

3.3.1.2.3 Exception to GALL for XI.M2, "Water Chemistry"

Aging of standby liquid control (SBLC) system components not in the reactor coolant pressure boundary section of the SBLC system relies on monitoring and control of SBLC makeup water chemistry. The makeup water is monitored in lieu of the storage tank because the sodium pentaborate maintained in the storage tank would mask most of the chemistry parameters monitored. The effectiveness of the water chemistry program will be verified by a one-time VT-3 inspection of a Dresden SBLC pump discharge valve and a Quad Cities SBLC pump casing as discussed in aging management program One-Time Inspection (B.1.23.)

3.3.2 Components or aging effects that are not addressed in NUREG-1801 for the auxiliary systems

Table 3.3-2,"Table 3.3-2 "Aging management review results for the auxiliary systems that are not addressed in NUREG-1801" contains aging management review results for the auxiliary systems for component groups that are not addressed in NUREG-1801.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.1	Accumulators	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen and CO2) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.2	Thermowells	Stainless Steel	Saturated Steam/ Condensate	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a plant heating steam environment.
3.3.2.3	Accumulators	Carbon Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ General galvanic pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider carbon steel components in a sodium pentaborate environment.
3.3.2.4	Fire Doors	Steel	Indoor and outdoor environments	Loss of material/ Wear	Fire Protection (B.1.18)	NUREG-1801 does not address Control Building and Reactor Building fire doors.
3.3.2.5	Accumulators	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.
3.3.2.6	Air Accumulator Vessels	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a moist air environment.
3.3.2.7	Air Handlers Heating/ Cooling (Aux&RW HVAC)	Tubes: Copper	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address raw water environments for air handler units in auxiliary systems.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.8	Air Handlers Heating/ Cooling (Aux&RW HVAC)	Tubes: Copper; Tubesheet: Stainless Steel; End Bells: Carbon Steel; Fins: Aluminum	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel, carbon steel, aluminum subcomponents; or raw water environments; for air handler units in auxiliary systems.
3.3.2.9	Air Handlers Heating/ Cooling (Aux&RW HVAC)	Tubes: Copper; Tubesheet: Stainless Steel; End Bells: Carbon Steel; Fins: Aluminum	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel, carbon steel, aluminum subcomponents; or raw water environments; for air handler units in auxiliary systems.
3.3.2.10	Air Handlers Heating/ Cooling (CR HVAC)	Tubes: Copper	Tube side: Refrigerant; Shell side: Warm moist air	Buildup of Deposit/ Fouling	Heat Exchanger Test and Inspection Activities (B.2.6)	NUREG-1801 does not address fouling for air handler units.
3.3.2.11	Air Handlers Heating/ Cooling (CR HVAC)	Tubes: Copper; Tubesheet: Copper; End Bells: Copper; Fins: Aluminum	Tube side: Refrigerant; Shell side: Warm moist air	Cracking/ Mech Fatigue	Heat Exchanger Test and Inspection Activities (B.2.6)	NUREG-1801 does not address aluminum subcomponents, or refrigerant environments for air handler units in auxiliary systems.
3.3.2.12	Air Handlers Heating/ Cooling (DGB HVAC)	Tubes: Copper	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address raw water environments for air handler units in auxiliary systems.
3.3.2.13	Air Handlers Heating/ Cooling (DGB HVAC)	Tubes: Copper	Tube side: Refrigerant; Shell side: Warm moist air	Buildup of Deposit/ Fouling	Heat Exchanger Test and Inspection Activities (B.2.6)	NUREG-1801 does not address fouling for air handler units.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.14	Air Handlers Heating/ Cooling (DGB HVAC)	Tubes: Copper; End Bells: Galvanized Steel; Fins: Aluminum	Tube side: Refrigerant; Shell side: Warm moist air	Loss of Material/ Galvanic Corrosion, Wear, Pitting Corrosion, Crevice Corrosion	Heat Exchanger Test and Inspection Activities (B.2.6)	NUREG-1801 does not address aluminum or galvanized steel subcomponents, or refrigerant environments for air handler units in auxiliary systems.
3.3.2.15	Air Handlers Heating/ Cooling (DGB HVAC)	Tubes: Copper; Tubesheet: Carbon Steel; End Bells: Carbon Steel; Fins: Aluminum	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address carbon steel or aluminum subcomponents; or raw water environments; for air handler units in auxiliary systems.
3.3.2.16	Air Handlers Heating/ Cooling (DGB HVAC)	Tubes: Copper; Tubesheet: Carbon Steel; End Bells: Carbon Steel; Fins: Aluminum	Tube side: Open cycle cooling water (raw water); Shell side: Warm moist air	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address carbon steel or aluminum subcomponents; or raw water environments; for air handler units in auxiliary systems.
3.3.2.17	Closure Bolting	Cast Iron	Soil and groundwater	Loss of Material/ Pitting, Crevice Corrosion, Selective Leaching and MIC	Selective Leaching of Materials (B.1.24) and Buried Piping & Tanks Inspection (B.1.25)	NUREG-1801 does not address buried Fire Main cast iron bolting.
3.3.2.18	Closure Bolting	High Strength Low Alloy Steel	Outdoor ambient conditions	Loss of Material/ General corrosion and wear	Bolting Integrity (B.1.12)	NUREG-1801 does not address high strength low alloy steel bolting in an outdoor environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.19	Closure Bolting	High Strength Low Alloy Steel	Raw water (submerged)	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and macro organisms	Bolting Integrity (B.1.12)	NUREG-1801does not address pump casing bolting in a submerged (raw water) environment.
3.3.2.20	Closure Bolting	High Strength Low Alloy Steel	Soil and groundwater	Loss of material/ Pitting crevice and microbiologically influenced corrosion	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address buried Fire Main high strength low alloy steel bolting.
3.3.2.21	Component External Surfaces (filters/strainers, piping and fittings, heat exchangers, lubricators, vaporizers (tanks), air handlers (heating/cooling))	Aluminum	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address aluminum in plant indoor environment. Aluminum is a reactive metal, but it develops an aluminum oxide film that protects it from further corrosion. Therefore, no viable aging effects exist in this environment.
3.3.2.22	Component External Surfaces (piping and fittings, tubing)	Aluminum	Outdoor ambient conditions	Loss of material/ Pitting	Bolting Integrity (B.1.12)	NUREG-1801 does not address aluminum components in plant outdoor ambient conditions.
3.3.2.23	Component External Surfaces (valves, filters/ strainers, thermowells, dampers, piping and fittings, restricting orifices)	Brass or Bronze	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address brass or bronze in the plant indoor environment. The plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of brass or bronze components.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.24	Component External Surfaces (valves, dampeners)	Brass or Bronze	Air, moisture, humidity, and leaking fluid	Loss of material/ Pitting and crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address Auxiliary System brass or bronze components in a high moisture (pump vault) indoor environment.
3.3.2.25	Component External Surfaces (valves, filters/strainers)	Brass or Bronze	Outdoor ambient conditions	Loss of material/ Pitting and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address auxiliary system brass or bronze components in an outdoor environment.
3.3.2.26	Component External Surfaces (piping and fittings, sprinklers, pumps, valves, thermowells, heat exchangers)	Carbon Steel	Air, moisture, humidity, and leaking fluid	Loss of material/ General pitting crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address auxiliary system carbon steel components in a high moisture (pump vault) indoor environment.
3.3.2.27	Component External Surfaces (piping and fittings, valves)	Carbon Steel	Containment Nitrogen	None	None	NUREG-1801 does not address carbon steel components in a containment nitrogen environment. Containment nitrogen is not conducive to promoting aging degradation of carbon steel.
3.3.2.28	Component External Surfaces (piping and fittings)	Carbon Steel	Encased in Concrete	None	None	NUREG-1801 does not address steel piping encased in concrete. EPRI Tools Appendix E, Rev. 3 concludes that concrete is not conducive to promoting aging degradation of carbon steel components.
3.3.2.29	Component External Surfaces (piping and fittings, filters/strainers, mufflers, heat exchangers, equipment enclosures, valves)	Carbon Steel	Outdoor ambient conditions	Loss of material/ General pitting crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address carbon steel components in plant outdoor ambient conditions.
3.3.2.30	Component External Surfaces (piping and fittings)	Carbon Steel	Outdoor ambient conditions	Loss of material/ General pitting crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address carbon steel fire protection piping in plant outdoor ambient conditions.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.31	Component External Surfaces (valves, filters/strainers, pumps, heat exchangers, traps)	Cast Iron	Air, moisture, humidity, and leaking fluid	Loss of material/ Pitting and crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address auxiliary system cast iron components in a high moisture (pump vault) indoor environment.
3.3.2.32	Component External Surfaces (fire hydrants, valves)	Cast Iron	Outdoor ambient conditions	Loss of material/ Pitting and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address cast iron fire protection components in an outdoor environment.
3.3.2.33	Component External Surfaces (piping and fittings)	Cast Iron	Soil and groundwater	Loss of Material/ Pitting, Crevice Corrosion, Selective Leaching and MIC	Selective Leaching of Materials (B.1.24) and Buried Piping & Tanks Inspection (B.1.25)	NUREG-1801 does not address buried cast iron fire main pipe fittings.
3.3.2.34	Component External Surfaces (tubing, heat exchangers, piping and fittings)	Copper	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address copper in the plant indoor environment. The plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of copper components.
3.3.2.35	Component External Surfaces (tubing, restricting orifices)	Copper	Outdoor ambient conditions	Loss of material/ Pitting and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address copper components in plant outdoor ambient conditions.
3.3.2.36	Component External Surfaces (sight glasses)	Glass	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address glass components in a plant indoor environment. A plant indoor environment is not conducive to promoting aging degradation of glass components. Glass in this environment does not have any applicable aging effect.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.37	Component External Surfaces (valves)	Iron Ductile	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address ductile iron valves in a plant indoor environment. The plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of ductile iron components.
3.3.2.38	Component External Surfaces (sprinklers, piping and fittings)	Iron Malleable	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address malleable iron components in the plant indoor environment. The plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of malleable iron components.
3.3.2.39	Component External Surfaces (piping and fittings)	Polyvinyl Chloride (PVC)	Soil and groundwater	None	None	NUREG-1801 does not address PVC in a buried environment. PVC is relatively unaffected by water, concentrated alkaline, and non-oxidizing acids, oils, and ozone. Therefore, no viable aging effects exist in this environment.
3.3.2.40	Component External Surfaces (valves, piping and fittings, filters/ strainers, restricting orifices, orifice bodies, , dampeners, accumulators, flow elements, tubing, manifolds, rupture discs, pumps, housing and supports, thermowells, tanks, vaporizers (tanks))	Stainless Steel	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address stainless steel alloys in the plant indoor environment. Stainless steel materials are not subject to any viable aging mechanism in the absence of aggressive chemical species.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.41	Component External Surfaces (restricting orifices, orifice bodies, valves, tubing, pulsation dampeners)	Stainless Steel	Air, moisture, humidity, and leaking fluid	Loss of material/ Pitting and crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address auxiliary system stainless steel components in a high moisture (pump vault) indoor environment.
3.3.2.42	Component External Surfaces (piping and fittings, valves, tubing)	Stainless Steel	Containment Nitrogen	None	None	NUREG-1801 does not address stainless steel components in a containment nitrogen environment. Containment nitrogen is not conducive to promoting aging degradation of stainless steel alloys.
3.3.2.43	Component External Surfaces (piping and Fittings, tubing)	Stainless Steel	Outdoor ambient conditions	None	None	NUREG-1801 does not address stainless steel in the plant outdoor environment. Stainless steel materials are not subject to any viable aging mechanism in the absence of aggressive chemical species.
3.3.2.44	Component External Surfaces (valves, piping and fittings)	Steel Saran Lined	Air, moisture, humidity, and leaking fluid	Loss of material/ General pitting crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address saran lined steel components in a plant indoor environment. The external surface of the components is unlined carbon steel.
3.3.2.45	Component External Surfaces (valves, piping and fittings)	Titanium	Air, moisture, humidity, and leaking fluid	None	None	NUREG-1801 does not address titanium components. The high moisture (pump vault) indoor environment does not promote aging degradation of these titanium components as they are not exposed to high chloride concentrations at high temp.
3.3.2.46	Dampeners	Brass or Bronze	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a warm, moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.47	Dampeners	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.48	Diffusers	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (refrigerant) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.49	Duct Fittings, Hinges, Latches	Aluminum-Zinc Alloy	Warm, moist air	None	None	NUREG-1801 does not address components made of aluminum-zinc alloy. A warm, moist air environment is not conducive to promoting aging degradation of aluminum-zinc alloy components.
3.3.2.50	Filters/ Strainers	Aluminum	Diesel fuel oil	Loss of Material/ General pitting crevice and microbiologically influenced corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address aluminum components in a fuel oil environment.
3.3.2.51	Filters/ Strainers	Brass or Bronze	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of brass or bronze components.
3.3.2.52	Filters/ Strainers	Brass or Bronze	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address brass or bronze components in a saturated air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.53	Filters/ Strainers	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (refrigerant) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.54	Filters/ Strainers	Cast Iron	Diesel fuel oil	Loss of Material/ General pitting crevice and microbiologically influenced corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address cast iron components in a fuel oil environment.
3.3.2.55	Filters/ Strainers	Cast Iron	Moist air	Loss of material/ General, pitting, and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a moist air environment.
3.3.2.56	Filters/ Strainers	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address selective leaching of cast iron in fire protection systems.
3.3.2.57	Filters/ Strainers	Cast Iron	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a plant heating steam environment.
3.3.2.58	Filters/ Strainers	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a moist air environment.
3.3.2.59	Debris Screens	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel debris screens and strainer elements.
3.3.2.60	Filters/ Strainers	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.61	Fire Hydrants	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address selective leaching of cast iron in fire protection systems.
3.3.2.62	Fire Proofing	Cementitious Fire Proofing	Indoor	None	None	NUREG-1801 does not address cementitious fireproofing in an indoor environment. A non-aggressive, vibration free plant indoor environment is not conductive to promoting aging of cementitious fireproofing.
3.3.2.63	Fire Wrap	Ceramic Fiber	Indoor	None	None	NUREG-1801 does not address ceramic fiber. Fire wrap in a plant indoor environment is not conducive to promoting aging of ceramic fiber firewrap.
3.3.2.64	Flexible Hoses	Elastomers Neoprene and Similar Materials	Dry Gas	Hardening and loss of strength/ Elastomer degradation	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a dry gas (moisture free) environment.
3.3.2.65	Flexible Hoses	Elastomers Neoprene and Similar Materials	Moist air	Hardening and loss of strength/ Elastomer degradation	One-Time Inspection (B.1.23)	NUREG-1801 does not address elastomers in a moist air environment.
3.3.2.66	Flexible Hoses	Elastomers Neoprene and Similar Materials	Saturated air	Hardening and loss of strength/ Elastomer degradation	One-Time Inspection (B.1.23)	NUREG-1801 does not address elastomers in a saturated air environment.
3.3.2.67	Flexible Hoses	Elastomers Neoprene and Similar Materials	Warm, moist air	Hardening and loss of strength/ Elastomer degradation	One-Time Inspection (B.1.23)	NUREG-1801 does not address flexible hoses in a warm, moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.68	Flow Elements	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.69	Flow Elements	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.70	Flow Elements	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.
3.3.2.71	Flow Elements	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.
3.3.2.72	Flow Elements	Stainless Steel	Treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.73	Flow Elements	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel flow elements in a warm, moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.74	Fuel Grapples	Stainless Steel	Chemically treated oxygenated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address the stainless steel fuel grapple.
3.3.2.75	Fuel Pool Gates	Aluminum	Chemically treated oxygenated water	Loss of material/ General and pitting corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a fuel pool environment.
3.3.2.76	Fuel Preparation Machines	Aluminum	Chemically treated oxygenated water	Loss of material/ General and pitting corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a fuel pool environment.
3.3.2.77	Heat Exchangers	Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Crack initiation and growth/ Stress corrosion cracking	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not evaluate this heat exchanger and intended function combination.
3.3.2.78	Heat Exchangers	Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Loss of Material/ General, MIC, Erosion/ FAC, Wear, Pitting, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not evaluate this heat exchanger and intended function combination.
3.3.2.79	Heat Exchangers	Tubes: 70-30 Cu-Ni	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address Cu-Ni tubing for LPCI heat exchangers. Fouling from non-microbiological sources in not included in NUREG-1801.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.80	Heat Exchangers	Tubes: 70-30 Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address Cu-Ni tubing for LPCI heat exchangers.
3.3.2.81	Heat Exchangers	Tubes: 70-30 Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address Cu-Ni tubing for LPCI heat exchangers.
3.3.2.82	Heat Exchangers	Tubes: 90-10 Cu-Ni	Tube side: Open cycle cooling water (raw water); Shell side: Refrigerant	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	This heat exchanger does not match the material/ environment combination evaluated in NUREG-1801.
3.3.2.83	Heat Exchangers	Tubes: 90-10 Cu-Ni	Tube side: Reactor coolant water; Shell side: Closed-cycle cooling water	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address Cu-Ni tubes for shutdown cooling heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.84	Heat Exchangers	Tubes: 90-10 Cu-Ni; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Refrigerant	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13)	This heat exchanger does not match the material/ environment combination evaluated in NUREG-1801.
3.3.2.85	Heat Exchangers	Tubes: 90-10 Cu-Ni; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Refrigerant	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13)	This heat exchanger does not match the material/ environment combination evaluated in NUREG-1801.
3.3.2.86	Heat Exchangers	Tubes: 90-10 Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Reactor coolant water; Shell side: Closed-cycle cooling water	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address Cu-Ni tubes for shutdown cooling heat exchangers.
3.3.2.87	Heat Exchangers	Tubes: 90-10 Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Carbon Steel	Tube side: Reactor coolant water; Shell side: Closed-cycle cooling water	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Water Chemistry (B.1.2), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address Cu-Ni tubes for shutdown cooling heat exchangers. General corrosion, galvanic corrosion, erosion or FAC, and wear are not included in NUREG-1801 for shutdown cooling heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.88	Heat Exchangers	Tubes: Admiralty Brass	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address admiralty brass tubing for RHR system auxiliary heat exchangers.
3.3.2.89	Heat Exchangers	Tubes: Admiralty Brass; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address admiralty brass or cast iron subcomponents for RHR system auxiliary heat exchangers.
3.3.2.90	Heat Exchangers	Tubes: Admiralty Brass; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address admiralty brass or cast iron subcomponents for RHR system auxiliary heat exchangers. Galvanic corrosion, erosion or FAC, and wear are not included in NUREG-1801 for ECCS heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.91	Heat Exchangers	Tubes: Admiralty Brass; Tubesheet: Carbon Steel; Channel Head: Carbon Steel	Raw, untreated fresh water	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address admiralty brass tubes or carbon steel tubesheets for open-cycle heat exchangers in auxiliary systems.
3.3.2.92	Heat Exchangers	Tubes: Admiralty Brass; Tubesheet: Carbon Steel; Channel Head: Carbon Steel	Raw, untreated fresh water	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address admiralty brass tubes or carbon steel tubesheets for open-cycle heat exchangers in auxiliary systems.
3.3.2.93	Heat Exchangers	Tubes: Austenitic Stainless Steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems.
3.3.2.94	Heat Exchangers	Tubes: Austenitic Stainless Steel; Tubesheet: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems. Erosion or FAC, and wear are not included in NUREG-1801 auxiliary systems for heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.95	Heat Exchangers	Tubes: Austenitic Stainless Steel; Tubesheet: Carbon Steel; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems.
3.3.2.96	Heat Exchangers	Tubes: Copper	Tube side: Closed cooling water; Shell side: Warm moist air	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes or air environments for auxiliary system heat exchangers.
3.3.2.97	Heat Exchangers	Tubes: Copper	Tube side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Lubricating oil	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address lube oil coolers.
3.3.2.98	Heat Exchangers	Tubes: Copper	Tube Side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Warm moist air	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes or air environments for auxiliary system heat exchangers.
3.3.2.99	Heat Exchangers	Tubes: Copper	Tube side: Lubricating Oil; Shell side: Closed cooling water	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address lube oil coolers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.100	Heat Exchangers	Tubes: Copper; Channel Head: Cast Steel; Shell: Cast Steel	Tube side: Closed cooling water; Shell side: Warm moist air	Cracking/ Mech Fatigue, SCC	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes or air environments for auxiliary system heat exchangers.
3.3.2.101	Heat Exchangers	Tubes: Copper; Channel Head: Cast Steel; Shell: Cast Steel	Tube side: Closed cooling water; Shell side: Warm moist air	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes or air environments for auxiliary system heat exchangers.
3.3.2.102	Heat Exchangers	Tubes: Copper; Channel Head: Cast Steel; Shell: Cast Steel	Tube Side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Warm moist air	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes, cast steel subcomponents or air environments for auxiliary system heat exchangers.
3.3.2.103	Heat Exchangers	Tubes: Copper; Channel Head: Cast Steel; Shell: Cast Steel	Tube Side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Warm moist air	Cracking/ Mech Fatigue	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes, cast steel subcomponents or air environments for auxiliary system heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.104	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Fins: Aluminum	Tube Side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Warm moist air	Cracking/ Mech Fatigue	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes, aluminum subcomponents or air environments for auxiliary systems heat exchangers.
3.3.2.105	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Fins: Aluminum	Tube Side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Warm moist air	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address copper tubes, aluminum subcomponents or air environments for auxiliary systems heat exchangers.
3.3.2.106	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Lubricating oil	Cracking/ Mech Fatigue	Closed-Cycle Cooling Water System (B.1.14), Lube Oil Monitoring Activities (B.2.5)	NUREG-1801 does not address lube oil coolers.
3.3.2.107	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Glycol-based cooling water (closed-cycle cooling water); Shell side: Lubricating oil	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24), Lubricating Oil Monitoring Activities (B.2.5)	NUREG-1801 does not address lube oil coolers. Erosion or FAC, and wear are not addressed in NUREG-1801 for heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.108	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Lubricating Oil; Shell side: Closed cooling water	Cracking/ Mech Fatigue, SCC	Closed-Cycle Cooling Water System (B.1.14), Lube Oil Monitoring Activities (B.2.5)	NUREG-1801 does not address lube oil coolers.
3.3.2.109	Heat Exchangers	Tubes: Copper; Tubesheet: Carbon Steel; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Lubricating Oil; Shell side: Closed cooling water	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Closed-Cycle Cooling Water System (B.1.14), Lube Oil Monitoring Activities (B.2.5)	NUREG-1801 does not address lube oil coolers.
3.3.2.110	Heat Exchangers	Tubes: Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Cu-Ni	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address carbon steel tubesheets, or Cu-Ni shells in heat exchangers between open/ closed-cycle cooling systems in auxiliary systems.
3.3.2.111	Heat Exchangers	Tubes: Cu-Ni; Tubesheet: Carbon Steel; Channel Head: Carbon Steel; Shell: Cu-Ni	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address carbon steel tubesheets, or Cu-Ni shells in heat exchangers between open/ closed-cycle cooling systems. Erosion or FAC and wear are not included in NUREG-1801 auxiliary systems for heat exchangers.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.112	Heat Exchangers	Tubes: stainless steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems.
3.3.2.113	Heat Exchangers	Tubes: stainless steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to raw water environments.
3.3.2.114	Heat Exchangers	Tubes: stainless steel	Tube side: Reactor coolant water; Shell side: Closed-cycle cooling water	Buildup of Deposit/ Fouling	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address fouling of stainless steel tubing in shutdown cooling system heat exchangers.
3.3.2.115	Heat Exchangers	Tubes: stainless steel	Tube side: Torus Water (demineralized water); Shell side: Open cycle cooling water (raw water)	Buildup of Deposit/ Fouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to raw water environments.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.116	Heat Exchangers	Tubes: stainless steel; tubesheet: carbon steel; channel head: carbon steel; shell: carbon steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Pitting Corrosion, Crevice Corrosion	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems. Erosion or FAC, and wear are not included in NUREG-1801 auxiliary systems for heat exchangers.
3.3.2.117	Heat Exchangers	Tubes: stainless steel; tubesheet: carbon steel; channel head: carbon steel; shell: carbon steel	Tube side: Open cycle cooling water (raw water); Shell side: Closed cooling water (treated water)	Cracking/ Mech Fatigue, SCC	Open-Cycle Cooling Water System (B.1.13), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address stainless steel tubing in heat exchangers between open/ closed-cycle cooling systems.
3.3.2.118	Heat Exchangers	Tubes: Stainless Steel; Tubesheet: Cast Iron; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to a raw water environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.119	Heat Exchangers	Tubes: Stainless Steel; Tubesheet: Cast Iron; Channel Head: Cast Iron; Shell: Carbon Steel	Tube side: Open cycle cooling water (raw water); Shell side: Torus Water (demineralized water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to a raw water environment. Erosion or FAC, and wear are not included in NUREG-1801 for ECCS heat exchangers.
3.3.2.120	Heat Exchangers	Tubes: Stainless Steel; Tubesheet: Cast Iron; Shell: Cast Iron	Tube side: Torus Water (demineralized water); Shell side: Open cycle cooling water (raw water)	Loss of Material/ General Corrosion, Galvanic Corrosion, MIC, Erosion or FAC, Wear, Selective Leaching, Pitting Corrosion, Crevice Corrosion	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to raw water environments. Galvanic corrosion, erosion or FAC, and wear are not included in NUREG-1801 for ECCS heat exchangers.
3.3.2.121	Heat Exchangers	Tubes: Stainless Steel; Tubesheet: Cast Iron; Shell: Cast Iron	Tube side: Torus Water (demineralized water); Shell side: Open cycle cooling water (raw water)	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address stainless steel tubing in auxiliary system heat exchangers exposed to raw water environments.
3.3.2.122	Insulation	Closed-Cell Foam	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address closed-cell foam insulation. Closed-cell foam insulation is susceptible to degradation when exposed to UV light. Plant indoor environment is not conducive to promoting aging degradation of closed-cell foam insulation.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.123	Insulation Jacketing	Aluminum	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address aluminum insulation jacketing. Aluminum is reactive, but develops an oxide film that protects it from further corrosion. No viable aging effects exist in the indoor environment for aluminum insulation jacketing.
3.3.2.124	Isolation Barriers	Carbon Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	10 CFR Part 50, Appendix J (B.1.28)	NUREG-1801 does not address carbon steel components in a warm, moist air environment.
3.3.2.125	Isolation Barriers	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	10 CFR Part 50, Appendix J (B.1.28)	NUREG-1801 does not address stainless steel components in a warm, moist air environment.
3.3.2.126	Lubricators	Aluminum	Moist air	Loss of material/ General and pitting corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components made of aluminum.
3.3.2.127	Lubricators	Glass	Moist air	None	None	NUREG-1801 does not address glass components. A diesel staring air environment is not conducive to promoting aging degradation of glass components. Glass in this environment does not have any applicable aging effect.
3.3.2.128	Manifolds	Stainless Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.129	Masonry Walls	Concrete Block	Ambient environment inside building	Cracking/ Restraint; shrinkage; creep; aggressive environment	Fire Protection (B.1.18) and Structures Monitoring Program (B.1.30)	NUREG-1801 does not address masonry walls with an aging management program of fire protection.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.130	NSR Vents or Drains, Piping and Valves	Carbon Steel, Stainless Steel, Brass or Bronze	Air, moisture, humidity, and leaking fluid	Loss of material/ Corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address NSR vents or drains in an air, moisture, humidity and leaking fluid environment.
3.3.2.131	Pipe Joint Gaskets	Rubber	Soil and groundwater	Change in Material Properties/ Elastomer degradation and loss of resiliency	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address Auxiliary System rubber pipe gasket material in a buried environment.
3.3.2.132	Piping and Fittings	Aluminum	Moist air	Loss of material/ General and pitting corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components made of aluminum.
3.3.2.133	Piping and Fittings	Brass or Bronze	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Cracking/ Stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider brass or bronze in closed cooling water environments.
3.3.2.134	Piping and Fittings	Brass or Bronze	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Loss of Material/ General, Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider brass or bronze in closed cooling water environments.
3.3.2.135	Piping and Fittings	Brass or Bronze	Diesel fuel oil	Loss of material/ General pitting crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a fuel oil environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.136	Piping and Fittings	Brass or Bronze	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.
3.3.2.137	Piping and Fittings	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.138	Piping and Fittings	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (halon, CO2, or nitrogen) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.139	Piping and Fittings	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a lubricating oil environment.
3.3.2.140	Piping and Fittings	Carbon Steel	Oxygenated water 93°C - 288°C (200°F-550°F)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in oxygenated water environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.141	Piping and Fittings	Carbon Steel	Raw water (submerged)	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and macro organisms	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address Auxiliary System carbon steel piping in a submerged (raw water) environment.
3.3.2.142	Piping and Fittings	Carbon Steel	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a plant heating steam environment.
3.3.2.143	Piping and Fittings	Carbon Steel	Treated water	Loss of material/ General, pitting, and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.144	Piping and Fittings	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address warm, moist air as an environment in which carbon steel is to be managed.
3.3.2.145	Piping and Fittings	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel piping and fittings in a warm, moist air environment.
3.3.2.146	Piping and Fittings	Carbon Steel	Wet Gas	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.147	Piping and Fittings	Cast Iron	Chemically treated demineralized water <90°C (194°F)	Loss of material/ General, pitting and crevice corrosion, selective leaching and microbiologically influenced corrosion	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider cast iron in a diesel generator cooling water subsystem.
3.3.2.148	Piping and Fittings	Cast Iron	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General pitting crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a lubricating oil environment.
3.3.2.149	Piping and Fittings	Cast Iron	Moist air	Loss of material/ General, pitting, and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not include cast iron components in a moist air environment.
3.3.2.150	Piping and Fittings	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address selective leaching of cast iron in fire protection systems.
3.3.2.151	Piping and Fittings	Copper	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Loss of material/ Crevice, galvanic, pitting corrosion and MIC	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider copper in a diesel generator cooling water subsystem.
3.3.2.152	Piping and Fittings	Copper	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. This refrigerant environment is not conducive to promoting aging degradation of copper components. Copper is not subject to any viable aging mechanism in this environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.153	Piping and Fittings	Iron Ductile	Raw water	Loss of material/ General galvanic pitting crevice microbiologically influenced corrosion and biofouling	Fire Water System (B.1.19)	NUREG-1801 does not address ductile iron.
3.3.2.154	Piping and Fittings	Iron Ductile	Soil and groundwater	Loss of material/ Pitting crevice and microbiologically influenced corrosion	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address buried ductile iron fire main piping.
3.3.2.155	Piping and Fittings	Iron Malleable	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Loss of Material/ General, Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider malleable iron in a diesel generator cooling water subsystem.
3.3.2.156	Piping and Fittings	Iron Malleable	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General pitting crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address malleable iron components in a lubricating oil environment.
3.3.2.157	Piping and Fittings	Iron Malleable	Raw water	Loss of material/ General galvanic pitting crevice microbiologically influenced corrosion and biofouling	Fire Water System (B.1.19)	NUREG-1801 does not address malleable iron.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.158	Piping and Fittings	Polyvinyl Chloride (PVC)	Raw water	None	None	NUREG-1801 does not address PVC in a raw water environment. PVC is relatively unaffected by water, concentrated alkaline, and non-oxidizing acids, oils, and ozone. No viable aging effects exist for PVC in this environment.
3.3.2.159	Piping and Fittings	Stainless Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.160	Piping and Fittings	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.
3.3.2.161	Piping and Fittings	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.
3.3.2.162	Piping and Fittings	Stainless Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a lubricating oil environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.163	Piping and Fittings	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in diesel generator subsystems.
3.3.2.164	Piping and Fittings	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel components in a saturated air environment.
3.3.2.165	Piping and Fittings	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.166	Piping and Fittings	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel piping and fittings in a warm, moist air environment.
3.3.2.167	Piping and Fittings	Stainless Steel	Wet Gas	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.168	Piping and Fittings	Steel Saran Lined	Raw, untreated salt water or fresh water	Loss of Material/ General, pitting, crevice, galvanic, erosion, & MIC Flow Blockage/ Biofouling, silting & corrosion product buildup	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address saran-lined steel material for open-cycle cooling water piping. Material is being conservatively treated as carbon steel.
3.3.2.169	Piping and Fittings	Titanium	Raw, untreated salt water or fresh water	Flow Blockage/ Biofouling	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address titanium as a material for open-cycle cooling water piping.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.170	Pump Casings	Cast Iron	Raw water (submerged)	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and macro organisms	Open-Cycle Cooling Water System (B.1.13) or Fire Water System (B.1.19)	NUREG-1801 does not address auxiliary system cast iron pump casings in a submerged (raw water) environment.
3.3.2.171	Pump Casings	Cast Iron	Raw water (submerged)	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address auxiliary system cast iron pump casings in a submerged (raw water) environment.
3.3.2.172	Pump Casings	Cast Iron	Raw, untreated fresh water	Loss of material/ General, pitting and crevice corrosion, selective leaching and microbiologically influenced corrosion	Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron material for ultimate heat sink pumps.
3.3.2.173	Pump Casings	Iron Cast (Lined)	Air, moisture, humidity, and leaking fluid	Loss of material/ Pitting and crevice corrosion	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address cooling water lined cast iron pump casings in a high moisture (pump vault) indoor environment. The external surfaces are unlined cast iron.
3.3.2.174	Pumps	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack Initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.175	Pumps	Cast Iron	Chemically treated demineralized water <90°C (194°F)	Loss of Material/ General, Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider cast iron in a diesel generator cooling water subsystem.
3.3.2.176	Pumps	Cast Iron	Diesel fuel oil	Loss of Material/ General pitting crevice and microbiologically influenced corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address cast iron components in a fuel oil environment.
3.3.2.177	Pumps	Cast Iron	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General pitting crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a lubricating oil environment.
3.3.2.178	Pumps	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address selective leaching of cast iron in fire protection.
3.3.2.179	Pumps	Cast Iron	Raw, untreated salt water or fresh water	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and macro organisms	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address cast iron material for open-cycle cooling water pumps.
3.3.2.180	Pumps	Cast Iron	Raw, untreated salt water or fresh water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron material for open-cycle cooling water pumps.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.181	Pumps	Cast Iron	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a plant heating steam environment.
3.3.2.182	Pumps	Cast Iron	Treated water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.183	Pumps	Iron Cast (Lined)	Raw, untreated salt water or fresh water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address lined cast iron material for open-cycle cooling water pumps. Loss of material aging is evaluated as for unlined cast iron for conservatism.
3.3.2.184	Pumps	Iron Cast (Lined)	Raw, untreated salt water or fresh water	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and macro organisms	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address lined cast iron material for open-cycle cooling water pumps. Loss of material aging is evaluated as for unlined cast iron for conservatism.
3.3.2.185	Pumps	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.186	Restricting Orifices	Brass or Bronze	25-288°C (77-550°F) demineralized water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address non-safety related components in a demineralized water environment.
3.3.2.187	Restricting Orifices	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.188	Restricting Orifices	Carbon Steel	Treated water	Loss of material/ General, pitting, and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.189	Restricting Orifices	Copper	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. This nitrogen environment is not conducive to promoting aging degradation of copper components. Copper is not subject to any viable aging mechanism in this environment.
3.3.2.190	Restricting Orifices	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.
3.3.2.191	Restricting Orifices	Stainless Steel	Diesel fuel oil	Loss of material/ Pitting and crevice corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address stainless steel components in a fuel oil environment.
3.3.2.192	Restricting Orifices	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a moist air environment.
3.3.2.193	Restricting Orifices	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel piping components in a warm, moist air environment.
3.3.2.194	Rupture Discs	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.195	Sample Pumps	Stainless Steel	Moist containment atmosphere (air/ nitrogen), steam, or demineralized water	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in moist containment atmosphere (air/ nitrogen)environment.
3.3.2.196	Sight Glasses	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (refrigerant) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.197	Sight Glasses	Carbon Steel	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a building heating steam environment.
3.3.2.198	Sight Glasses	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a warm, moist air environment.
3.3.2.199	Sight Glasses	Carbon Steel	Wet Gas	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.200	Sight Glasses	Glass	Chemically treated demineralized water <90°C (194°F)	None	None	NUREG-1801 does not address glass components in a chemically treated water environment. Glass is not subject to any viable aging effect in this environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.201	Sight Glasses	Glass	Fuel oil	None	None	NUREG-1801 does not address glass components in a fuel oil environment. A fuel oil environment is not conducive to promoting aging degradation of glass components. Glass in this environment does not have any applicable aging effect.
3.3.2.202	Sight Glasses	Glass	Lubricating oil (with contaminants and/ or moisture)	None	None	NUREG-1801 does not address glass components in a lubricating oil environment. A lubricating oil environment is not conducive to promoting aging degradation of glass components. Glass in this environment does not have any applicable aging effect.
3.3.2.203	Sight Glasses	Glass	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	None	None	NUREG-1801 does not address glass components in a sodium pentaborate environment. Glass is not subject to any viable aging effect in this environment.
3.3.2.204	Sight Glasses	Glass	Wet Gas	None	None	NUREG-1801 does not address glass components in a wet gas environment. A wet gas environment is not conducive to promoting aging degradation of glass components. Glass in this environment does not have any applicable aging effect.
3.3.2.205	Sprinklers	Brass or Bronze	Warm, moist air	Loss of material/ Pitting and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address brass and bronze in a warm, moist air as an environment for the fire protection system.
3.3.2.206	Sprinklers	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address warm, moist air as an environment for carbon steel.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.207	Steel Piles	Carbon Steel	Soil and groundwater	None	None	NUREG-1801 does not address carbon steel piles in a soil and ground water environment. The intended function of steel piles driven in undisturbed soils are not affected by corrosion.
3.3.2.208	Strainer Bodies	Cast Iron	Raw, untreated salt water or fresh water	Loss of Material/ General, pitting, crevice, galvanic, erosion, & MIC Flow Blockage/ Biofouling, silting & corrosion product buildup	Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron material for open-cycle cooling water strainers.
3.3.2.209	Strainers	Carbon Steel	Treated water	Loss of material/ General, pitting, and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.210	Tanks	Aluminum	Dry Gas	None	None	NUREG-1801 does not address aluminum components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of aluminum components.
3.3.2.211	Tanks	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.212	Tanks	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen and CO2) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.213	Tanks	Carbon Steel	Outdoor ambient conditions	Loss of material/ General pitting crevice corrosion	Aboveground Carbon Steel Tanks (B.1.20)	NUREG-1801 does not address outdoor carbon steel storage tanks other than for diesel fuel oil service.
3.3.2.214	Tanks	Carbon Steel	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a plant heating steam environment.
3.3.2.215	Tanks	Carbon Steel	Soil and groundwater	Loss of Material/ General pitting crevice and microbiologically influenced corrosion	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address buried carbon steel storage tanks.
3.3.2.216	Tanks	Carbon Steel	Wet Gas	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.217	Tanks	Fiberglass	Fuel oil, water (as contaminant)	Buildup of deposit/ Biofouling	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address fiberglass components in a fuel oil environment.
3.3.2.218	Tanks	Fiberglass	Soil and groundwater	None	None	NUREG-1801 does not address fiberglass tanks in a buried environment. Ultraviolet radiation will age fiberglass, however, this aging mechanism is not applicable to underground storage tanks. Therefore, no viable aging effects exist in this environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.219	Tanks	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.220	Thermowells	Brass or Bronze	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Cracking/ Stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider brass or bronze in closed cooling water environments.
3.3.2.221	Thermowells	Brass or Bronze	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Loss of Material/ General, Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider brass or bronze in closed cooling water environments.
3.3.2.222	Thermowells	Brass or Bronze	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Loss of Material/ Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider brass or bronze in Diesel Generator cooling water subsystem.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.223	Thermowells	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of carbon steel components.
3.3.2.224	Thermowells	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.
3.3.2.225	Thermowells	Stainless Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.226	Thermowells	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.
3.3.2.227	Thermowells	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.228	Traps	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel piping components in a warm, moist air environment.
3.3.2.229	Traps	Cast Iron	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a plant heating steam environment.
3.3.2.230	Filters/ Strainers	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel filters/strainers in a warm, moist air environment.
3.3.2.231	Tubing	Aluminum	Dry Gas	None	None	NUREG-1801 does not address aluminum components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of aluminum components.
3.3.2.232	Tubing	Brass or Bronze	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a moist air environment.
3.3.2.233	Tubing	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.234	Tubing	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (CO2) is not conducive to promoting aging degradation of carbon steel components.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.235	Tubing	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.
3.3.2.236	Tubing	Copper	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Cracking/ Stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.237	Tubing	Copper	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Loss of material/ Crevice, galvanic, pitting corrosion and MIC	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider copper in a diesel generator cooling water subsystem.
3.3.2.238	Tubing	Copper	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Loss of material/ Crevice, galvanic, pitting corrosion and MIC	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider copper in a diesel generator cooling water subsystem.
3.3.2.239	Tubing	Copper	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of copper components.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.240	Tubing	Copper	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address copper components in a lubricating oil environment.
3.3.2.241	Tubing	Copper	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address copper tubing as a material of construction.
3.3.2.242	Tubing	Copper	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address copper tubing as a material of construction.
3.3.2.243	Tubing	Copper	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address copper components in a plant heating steam environment.
3.3.2.244	Tubing	Copper	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address copper components in a warm, moist air environment.
3.3.2.245	Tubing	Stainless Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.246	Tubing	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.247	Tubing	Stainless Steel	Diesel fuel oil	Loss of material/ Pitting and crevice corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address stainless steel components in a fuel oil environment.
3.3.2.248	Tubing	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.
3.3.2.249	Tubing	Stainless Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a lubricating oil environment.
3.3.2.250	Tubing	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel piping components in a moist air environment.
3.3.2.251	Tubing	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel components in a saturated air environment.
3.3.2.252	Tubing	Stainless Steel	Saturated Steam/ Condensate	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a plant heating steam environment.
3.3.2.253	Tubing	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.254	Tubing	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel piping components in a warm moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.255	Tubing	Stainless Steel	Wet Gas	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.256	Turbochargers	Cast Iron	Hot diesel engine exhaust gases containing moisture and particulates	Loss of material/ General, pitting, and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in an engine exhaust gas environment.
3.3.2.257	Valves	Brass or Bronze	25-288°C (77-550°F) demineralized water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address non-safety related components in a demineralized water environment.
3.3.2.258	Valves	Brass or Bronze	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Cracking/ Stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider brass or bronze in closed cooling water environments.
3.3.2.259	Valves	Brass or Bronze	Diesel fuel oil	Loss of material/ General pitting crevice corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address brass or bronze components in a fuel oil environment.
3.3.2.260	Valves	Brass or Bronze	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of brass or bronze components.
3.3.2.261	Valves	Brass or Bronze	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.262	Valves	Brass or Bronze	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address brass or bronze components in a saturated air environment.
3.3.2.263	Valves	Brass or Bronze	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a plant heating steam environment.
3.3.2.264	Valves	Brass or Bronze	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address brass or bronze components in a warm, moist air environment.
3.3.2.265	Valves	Brass or Bronze	Warm, moist air	Loss of material/ Pitting and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address warm, moist air as an environment for brass and bronze.
3.3.2.266	Valves	Carbon Steel	25-288°C (77-550°F) demineralized water	Loss of material/ General, pitting, and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a demineralized water environment.
3.3.2.267	Valves	Carbon Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.268	Valves	Carbon Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen and CO2) is not conducive to promoting aging degradation of carbon steel components.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.269	Valves	Carbon Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ General galvanic pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address BWR components in a lubricating oil environment.
3.3.2.270	Valves	Carbon Steel	Oxygenated water 93°C - 288°C (200°F-550°F)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in an oxygenated water environment.
3.3.2.271	Valves	Carbon Steel	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a plant heating steam environment.
3.3.2.272	Valves	Carbon Steel	Treated water	Loss of material/ General, pitting, and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address non-safety related components in a treated water environment.
3.3.2.273	Valves	Carbon Steel	Warm, moist air	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel valves in a warm, moist air environment.
3.3.2.274	Valves	Carbon Steel	Wet Gas	Loss of material/ General (carbon steel only) pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.275	Valves	Cast Iron	Chemically treated demineralized water <90°C (194°F)	Loss of Material/ General, Galvanic, Pitting, Crevice Corrosion, Selective Leaching and MIC	Closed-Cycle Cooling Water System (B.1.14), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not consider cast iron in a diesel generator cooling water subsystem.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.276	Valves	Cast Iron	Raw water	Loss of Material/ General, pitting, crevice, galvanic, erosion, & MIC Flow Blockage/ Biofouling, silting & corrosion product buildup	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address cast iron valves in a raw water environment.
3.3.2.277	Valves	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron valves in a raw water environment.
3.3.2.278	Valves	Cast Iron	Raw, untreated fresh water	Loss of material/ General, pitting and crevice corrosion, selective leaching and microbiologically influenced corrosion	Open-Cycle Cooling Water System (B.1.13), Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron material for ultimate heat sink valves.
3.3.2.279	Valves	Cast Iron	Raw, untreated salt water or fresh water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron valves in a raw water environment.
3.3.2.280	Valves	Cast Iron	Raw, untreated salt water or fresh water	Loss of Material/ General, pitting, crevice, galvanic, erosion, & MIC Flow Blockage/ Biofouling, silting & corrosion product buildup	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address cast iron valves in a raw water environment.
3.3.2.281	Valves	Cast Iron	Raw, untreated salt water or fresh water	Loss of Material/ General, pitting, crevice, galvanic, erosion, and MIC	One-Time Inspection (B.1.23)	NUREG-1801 does not address NSR cast iron valves in a raw water environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.282	Valves	Cast Iron	Saturated Steam/ Condensate	Loss of material/ General corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a plant heating steam environment.
3.3.2.283	Valves	Cast Iron	Warm, moist air	Loss of material/ General, pitting, and crevice corrosion	Fire Water System (B.1.19)	NUREG-1801 does not address warm, moist air as an environment for cast iron.
3.3.2.284	Valves	Iron Ductile	Dry Gas	None	None	NUREG-1801 does not address ductile iron components in a dry gas (moisture free) environment. A moisture free gaseous environment (refrigerant) is not conducive to promoting aging degradation of ductile iron components.
3.3.2.285	Valves	Stainless Steel	25-288°C (77-550°F) demineralized water	Crack initiation and growth/ Stress corrosion cracking	Water Chemistry (B.1.2)	NUREG-1801 does not address non-safety related components in a demineralized water environment.
3.3.2.286	Valves	Stainless Steel	Chemically treated demineralized water < 90°C (194°F) (TTA-Nitrite based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider cracking in closed cooling water environments.
3.3.2.287	Valves	Stainless Steel	Chemically treated demineralized water <90°C (194°F) (Glycol based chemical treatment)	Crack initiation and growth/ Stress corrosion cracking Intergranular stress corrosion cracking	Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not consider stainless steel in a diesel generator cooling water subsystem.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.288	Valves	Stainless Steel	Diesel fuel oil	Loss of material/ Pitting and crevice corrosion	Fuel Oil Chemistry (B.1.21)	NUREG-1801 does not address stainless steel components in a fuel oil environment.
3.3.2.289	Valves	Stainless Steel	Dry Gas	None	None	NUREG-1801 does not address components in a dry gas (moisture free) environment. A moisture free gaseous environment (nitrogen) is not conducive to promoting aging degradation of stainless steel components.
3.3.2.290	Valves	Stainless Steel	Lubricating oil (with contaminants and/ or moisture)	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a lubricating oil environment.
3.3.2.291	Valves	Stainless Steel	Moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel valves in a moist air environment.
3.3.2.292	Valves	Stainless Steel	Oxygenated water 93°C - 288°C (200°F-550°F)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address crevice and pitting corrosion of stainless steel in treated water environment.
3.3.2.293	Valves	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel valves in a saturated air environment.
3.3.2.294	Valves	Stainless Steel	Sodium pentaborate solution at 21 - 32 °C (70 - 90°F) (~24,500 ppm B)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not consider loss of material for components in a sodium pentaborate environment.
3.3.2.295	Valves	Stainless Steel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel valves in a warm, moist air environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.296	Valves	Stainless Steel	Wet Gas	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.297	Valves	Steel Saran Lined	Raw, untreated salt water or fresh water	Loss of Material/ General, pitting, crevice, galvanic, erosion, & MIC Flow Blockage/ Biofouling, silting & corrosion product buildup	Open-Cycle Cooling Water System (B.1.13)	NUREG-1801 does not address saran-lined steel material for open-cycle cooling water valves.
3.3.2.298	Valves	Titanium	Raw, untreated salt water or fresh water	None	None	NUREG-1801 does not address titanium components. Raw, untreated fresh water is not an aggressive environment conducive to promoting aging degradation of titanium valves as it does not a contain high chlorides concentration at high temperature (>165°F).
3.3.2.299	Pumps	Stainless Steel	Wet Gas	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address components in a wet gas environment.
3.3.2.300	Component External Surfaces (piping and fittings, valves, sprinklers, filters/strainers, pumps, strainer bodies, ejectors, turbochargers)	Cast Iron	Air, moisture, and humidity < 100°C (212°F)	Loss of material/ Pitting and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address cast iron in the plant indoor environment.

Table 3.3-2 Aging management review results for the auxiliary systems that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.3.2.301	Valves (Fire Protection)	Cast Iron	Raw water	Loss of Material/ Selective Leaching	Selective Leaching of Materials (B.1.24)	NUREG-1801 does not address cast iron valves in a raw water environment.
3.3.2.302	Piping and Fittings	Aluminum	<90° C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.
3.3.2.303	Heat Exchangers	Tubes: Stainless Steel; Channel Head: Cast Steel; Shell: Cast Steel	Tube Side: Reactor Coolant water; Shell side: Closed-cycle cooling water	Cracking/ Mech Fatigue, SCC	Water Chemistry (B.1.2), Closed-Cycle Cooling Water System (B.1.14)	NUREG-1801 does not address cast steel subcomponents or cracking in shutdown cooling system heat exchangers.

3.4 AGING MANAGEMENT OF STEAM AND POWER CONVERSION SYSTEM

The following systems are evaluated as part of the steam and power conversion system:

- Main steam system
- Feedwater system
- Condensate and condensate storage system
- Main condenser
- Main turbine and auxiliaries
- Turbine oil system (in-scope for Quad Cities only)
- Main generator and auxiliaries (in-scope for Quad Cities only)

Components Evaluated Consistent with NUREG-1801

The components or component groups requiring aging management review in each of the steam and power conversion systems listed above are presented in Chapter 2. Aging management reviews were performed to assure that the component groups, materials, environments and aging effects referenced in NUREG –1801 are applicable to Dresden and Quad Cities and that the aging management program described in NUREG-1801 is appropriate.

When the components or component group and associated evaluations corresponded with an individual line item in NUREG-1801, Volume 2, the component aging management results were included in the appropriate line items in Table 3.4-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system" for the steam and power conversion system. Each line in Table 3.4-1 matches a line in Chapter 3 of NUREG-1800, that is applicable to Boiling Water Reactors (BWR) or to both Boiling Water Reactors and Pressurized Water Reactors (BWR/PWR).

Not all component types in the Dresden and Quad Cities steam and power conversion system are listed in NUREG-1801, Volume 2. However, the aging management reviews presented in NUREG-1801, Volume 2 were applied to additional component types if the following criteria were satisfied:

- Constructed of the same material as components in the NUREG-1801 line item,
- Assigned the same Component Intended Function as components in the NUREG-1801 line item,
- Located in the same environment as components in the NUREG-1801 line item, and
- Have exhibited the same aging effects identified in the NUREG-1801 line item.

Component types meeting these criteria have been included in the presentation of aging management review results in Table 3.4-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system." The third column of the table shows the component types included in each evaluation line. "NUREG-1801 Components" are those that correspond exactly with component types in NUREG-1801, Volume 2. "Evaluated with NUREG-1801 Components" shows the component types that meet the four (4) criteria above, and therefore share the same evaluation characteristics. Dresden and Quad Cities do not have all of the component types identified in NUREG-1801, Volume 2. The component type entries in the third column of Table 3.4-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system" under the "NUREG-1801 Components" heading are those components or component groups that were identified and evaluated at Dresden and Quad Cities.

Other Components Evaluated

Table 3.4-2 "Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801" presents the aging management review results for the remainder of the steam and power conversion system components. These entries result from aging management review results where the component type, material, environment or aging effect/mechanism differs from NUREG-1801, Volume 2 line item entries. Each line in Table 3.4-2 includes a line reference number, component group, material, environment, aging effect/mechanism, aging management program and discussion.

3.4.1 Aging management programs evaluated in NUREG-1801 that are relied upon for license renewal for the steam and power conversion system

Table 3.4-1, "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system" shows the component groups and aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion systems.

Table 3.4-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.4.1.1	Piping and fittings in main feedwater line, steam line and AFW piping (PWR only)	NUREG-1801 Components Piping and Fittings	Cumulative fatigue damage	TLAA, evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further Evaluation of cumulative fatigue damage is provided in Section 3.4.1.1.1 and Section 4.3.3.2.

Table 3.4-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system (Continued)

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.4.1.2	Piping and fittings, valve bodies and bonnets, pump casings, tanks, tubes, tubesheets, channel head and shell (except main steam system)	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Thermowells	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Water chemistry (B.1.2) and one-time inspection (B.1.23)	Yes, detection of aging effects is to be further evaluated	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2. Further evaluation of Loss of Material due to General, Pitting, and Crevice Corrosion is described in Section 3.4.1.1.2. Condensate pumps identified in NUREG-1801, line VIII.E.3-a and feedwater pumps identified in line VIII.D2.3-b are not in the scope of license renewal. Piping and fittings for the steam turbine and extraction steam systems identified in NUREG-1801, lines VIII.A.1-b and VIII.C1-b are not in the scope of license renewal. The condensate cleanup system components identified in NUREG-1801 line VII.E.6-a are not in the scope of license renewal. The condensate coolers / condensers in the condensate system identified in NUREG-1801, lines VIII.E.4-a and VIII.E.4-d and valves in the extraction steam system identified in line VIII.C.2-b are not in the scope of license renewal. Dresden and Quad Cities do not use carbon steel or stainless steel for the CST tanks as identified in NUREG-1801, lines VIII.E.5-a and VIII.E.5-b. Dresden and Quad Cities CST tanks are aluminum.

Table 3.4-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system (Continued)

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.4.1.3	External surface of carbon steel components	NUREG-1801 Components Carbon Steel Components (piping and fittings, valves, restricting orifices, thermowells, filters/strainers, tanks)	Loss of material due to general corrosion	Plant specific	Yes, plant specific	Further evaluation of General Corrosion is described in Section 3.4.1.1.3.
3.4.1.4	Carbon steel piping and valve bodies	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Restricting Orifices Thermowells	Wall thinning due to flow-accelerated corrosion	Flow-accelerated corrosion (B.1.11)	No	Consistent with NUREG-1801, with exception. The exceptions to flow accelerated corrosion are described in Section 3.4.1.2.1. Piping and fittings for the steam turbine and extraction steam system identified in NUREG-1801, VIII.A.1-a and VIII.C.1-a are not in the scope of license renewal. Valves for the extraction steam system and feedwater pumps in the feedwater system discussed in NUREG-1801, lines VIII.C.2-a and VIII.D2.3-a are not in the scope of license renewal.
3.4.1.5	Carbon steel piping and valve bodies in main steam system	NUREG-1801 Components Piping and Fittings Valves Evaluated with NUREG-1801 Components Restricting Orifices	Loss of material due to pitting and crevice corrosion	Water chemistry (B.1.2)	No	Consistent with NUREG-1801, with exception. The exceptions to Water Chemistry are described in Section B.1.2.

Table 3.4-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the steam and power conversion system (Continued)

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.4.1.6	Closure bolting in high-pressure or high-temperature systems	NUREG-1801 Components Closure Bolting	Loss of material due to general corrosion; crack initiation and growth due to cyclic loading and/or SCC.	Bolting integrity (B.1.12)	No	Consistent with NUREG-1801, with exception. The exceptions to Bolting Integrity are described in Section B.1.12.
3.4.1.7	Heat exchangers and coolers/ condensers serviced by open-cycle cooling water	See Discussion Column	Loss of material due to general (carbon steel only), pitting, and crevice corrosion, MIC, and biofouling; buildup of deposit due to biofouling	Open-cycle cooling water system (B.1.13)	No	Components are not in the scope of license renewal.
3.4.1.8	Heat exchangers and coolers/ condensers serviced by open-cycle cooling water	See Discussion Column	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Closed-cycle cooling water system (B.1.14)	No	Components are not in the scope of license renewal.
3.4.1.9	External surface of aboveground condensate storage tank	See Discussion Column	Loss of material due to general (carbon steel only), pitting, and crevice corrosion	Aboveground carbon steel tanks (B.1.20)	No	NUREG-1801 specifies carbon steel for the CST, however, Dresden and Quad Cities have tanks constructed of aluminum.
3.4.1.10	External surface of buried condensate storage tank and AFW piping	See Discussion Column	Loss of material due to general, pitting, and crevice corrosion and MIC	Buried piping and tanks surveillance or Buried piping and tanks inspection (B.1.25)	No, Yes, detection of aging effects and operating experience are to be further evaluated	Carbon steel material and buried environment does not exist at Dresden or Quad Cities

3.4.1.1 Further evaluation of aging management as recommended by NUREG-1801 for the steam and power conversion system

3.4.1.1.1 Cumulative Fatigue Damage (NUREG-1800, Section 3.4.2.2.1)

Cumulative fatigue damage of steam line and main feedwater piping is a TLAA as defined in 10 CFR 54.3. Cumulative fatigue damage of steam line and feedwater piping is required to be evaluated in accordance with 10 CFR 54.21(c)(1). The TLAA evaluation of steam line and feedwater piping outside the RCPB is addressed in Section 4.3.3.2.

3.4.1.1.2 Loss of Material due to General, Pitting, and Crevice Corrosion (NUREG-1800, Section 3.4.2.2.2)

An inspection of selected components exposed to a stagnant flow water environment will be conducted in accordance with aging management program One-Time Inspection (B.1.23.) The inspection of selected components will verify the effectiveness of the chemistry control program to manage loss of material due to general, pitting, and crevice corrosion in low flow or stagnant flow areas by ensuring that significant degradation is not occurring and the component intended function will be maintained during the extended period of operation. Examinations will be conducted on carbon and stainless steel components in an area where typically stagnant flow is present but occasionally there is flow, which will cause replenishment of the oxygen supply. Inspections will be conducted on the HPCI torus suction check valves, the HPCI booster pumps, and the control rod drive (CRD) scram valves. The carbon steel HPCI torus suction check valves are exposed to torus water and will undergo a visual exam followed by an ultrasonic exam if significant corrosion is observed, while the carbon steel HPCI booster pumps and the stainless steel CRD scram valves are exposed to condensate storage tank water and will undergo a visual examination. These components provide representative samples of the aging effects seen in steam and power conversion system.

3.4.1.1.3 General Corrosion (NUREG-1800, Section 3.4.2.2.4)

Aging management of the external surface of the main steam, feedwater, condensate and condensate storage system components in a sheltered environment with moist, warm air will be managed either by the Structures Monitoring Program (B.1.30) or by system engineer walkdowns performed by the Bolting Integrity (B.1.12) aging management activities.

3.4.1.2 Aging management programs or evaluations that are different than those described in NUREG-1801 for the steam and power conversion systems

3.4.1.2.1 Exception to NUREG-1801 for flow accelerated corrosion

Flow accelerated corrosion is an applicable aging mechanism for the main steam lines and the feedwater lines. Carbon steel components in the condensate system are not susceptible to flow accelerated corrosion and do not require aging management. This exception is based on the following:

1. EPRI TR-114882, "Non-Class 1 Mechanical Implementation Guideline and Mechanical Tools," states that flow rates less than 6 ft/sec do not need to be considered for FAC.

2. Dresden and Quad Cities flow rates in the condensate system are less than 6 ft/sec. Additionally, plant experience has not revealed flow accelerated corrosion in these lines.

For the evaluation of the HPCI and RCIC steam lines, an exception is taken to NUREG-1801 for item VIII.B2.1-b. The HPCI and RCIC steam piping and fittings are evaluated with NUREG-1801 line V.D2.1-f (Lines to HPCI and RCIC pump turbine) with the results presented in Table 3.2-1, reference number 3.2.1.12.

3.4.2 Components or aging effects that are not addressed in NUREG-1801 for the steam and power conversion system

Table 3.4-2, "Aging management review results for the steam and power conversion system" that are not addressed in NUREG-1801" contains aging management review results for the steam and power conversion system for component groups that are not addressed in NUREG-1801.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.1	Accumulators	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel components in a saturated air environment.
3.4.2.2	Closure Bolting	High Strength Low Alloy Steel	Outdoor ambient conditions	Loss of Material/General corrosion and wear	Bolting Integrity (B.1.12)	NUREG-1801 does not address closure bolting in an outdoor environment.
3.4.2.3	Component External Surfaces (piping and fittings, valves, tubing)	Aluminum	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address aluminum components in a plant indoor environment. Plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of aluminum components.
3.4.2.4	Component External Surfaces (piping and fittings, valves, thermowells, tubing)	Aluminum	Outdoor ambient conditions	Loss of material/ Pitting	Structures Monitoring Program (B.1.30)	NUREG-1801 does not address aluminum component external surfaces in an outdoor environment.
3.4.2.5	Component External Surfaces (piping and fittings, valves)	Carbon Steel	Air, moisture, and humidity where surface temp > 100°C (212°F)	None	None	NUREG-1801 does not address high temperature carbon steel external surfaces. A temperature limit of 212°F applies to all materials as moisture must be present for corrosion to occur.
3.4.2.6	Component External Surfaces (piping and fittings, valves, flow elements, thermowells)	Carbon Steel	Containment Nitrogen	None	None	NUREG-1801 does not address carbon steel in a containment nitrogen environment. A containment nitrogen environment is not conducive to promoting aging degradation.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.7	Component External Surfaces (piping and fittings, valves)	Carbon Steel	Outdoor ambient conditions	Loss of material/ General, pitting, and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address carbon steel component external surfaces in an outdoor environment.
3.4.2.8	Component External Surfaces (piping and fittings)	Carbon Steel	Soil and groundwater	Loss of Material/ General pitting crevice and microbiologically influenced corrosion	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address buried steam and power conversion system carbon steel components.
3.4.2.9	Component External Surfaces (pump casings)	Cast Iron	Air, moisture, and humidity < 100°C (212°F)	Loss of material/ Pitting and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address cast iron component external surfaces in an indoor environment.
3.4.2.10						Line left intentionally blank.
3.4.2.11	Component External Surfaces (piping and fittings, valves, dampeners, tanks, tubing, accumulators, heat exchangers, housings, pumps)	Stainless Steel	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address stainless steel in a plant indoor environment. Plant indoor environment is not an aggressive wetted environment conducive to promoting aging degradation of stainless steel components.
3.4.2.12	Component External Surfaces (piping and fittings, valves, thermowells)	Stainless Steel	Air, moisture, and humidity where surface temp > 100°C (212°F)	None	None	NUREG-1801 does not address high temperature stainless steel external surfaces. A temperature limit of 212°F applies to all materials as moisture must be present for corrosion to occur.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.13	Component External Surfaces (piping and fittings, valves, dampeners, filters/strainers, rupture discs, tanks, tubing, vacuum breakers)	Stainless Steel	Containment Nitrogen	None	None	NUREG-1801 does not address stainless steel in a containment nitrogen environment. A containment nitrogen environment is not conducive to promoting aging degradation.
3.4.2.14	Component External Surfaces (piping and fittings, valves, tubing)	Stainless Steel	Outdoor ambient conditions	Loss of material/ Pitting and crevice corrosion	Bolting Integrity (B.1.12)	NUREG-1801 does not address steam and power conversion system stainless steel component external surfaces in an outdoor environment.
3.4.2.15	Component External Surfaces (piping and fittings)	Stainless Steel	Soil and groundwater	Loss of material/ Pitting and crevice corrosion	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address steam and power conversion system buried stainless steel component external surfaces.
3.4.2.16	Filters/Strainers	Carbon Steel	Generator Hydrogen Seal Oil	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a generator hydrogen seal oil environment.
3.4.2.17	Filters/Strainers	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel components in a saturated air environment.
3.4.2.18	Flexible Hoses	Elastomers Neoprene and Similar Materials	Containment Nitrogen	None	None	NUREG-1801 does not address flexible hose elastomer materials in a containment nitrogen environment. A containment nitrogen environment is not conducive to promoting aging degradation.
3.4.2.19	Flexible Hoses	Elastomers Neoprene and Similar Materials	Saturated air	Hardening and loss of strength/ Elastomer degradation	One-Time Inspection (B.1.23)	NUREG-1801 does not address elastomers in a saturated air environment.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.20	Heat Exchangers	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address components in the main generator stator cooling environment.
3.4.2.21	Housings	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address NSR components in the main generator stator cooling environment.
3.4.2.22	Insulation	Calcium Silicate	Outdoor ambient conditions	None	None	NUREG-1801 does not address calcium silicate insulation. Plant outdoor environment is not conducive to promoting aging degradation of jacketed calcium silicate insulation.
3.4.2.23	Insulation Jacketing	Aluminum Jacketing	Outdoor ambient conditions	Insulation degradation/Loss of jacket leak-tight integrity	Structures Monitoring Program (B.1.30)	NUREG-1801 does not address aluminum insulation jacketing of outdoor piping.
3.4.2.24	Main Condenser Hotwells, False Floors	Carbon Steel	Steam	None	None	NUREG-1801 does not address main condenser components. There are no main condenser aging effects requiring management. Therefore, no aging management is required to maintain the intended function of containment holdup plate-out.
3.4.2.25	Main Condenser Tubes, Tubesheets	Stainless Steel	Open-cycle cooling water (raw water) side	None	None	NUREG-1801 does not address main condenser components. There are no main condenser aging effects requiring management. Therefore, no aging management is required to maintain the intended function of containment holdup plate-out.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.26	Main Condenser Tubes, Tubesheets	Stainless Steel	Steam	None	None	NUREG-1801 does not address main condenser components. There are no main condenser aging effects requiring management. Therefore, no aging management is required to maintain the intended function of containment holdup plate-out.
3.4.2.27	Main Condenser Waterboxes, Hatches	Carbon Steel	Air, moisture, and humidity < 100°C (212°F)	None	None	NUREG-1801 does not address the main condenser components. There are no main condenser aging effects requiring management. Therefore, no aging management is required to maintain the intended function of containment holdup plate-out.
3.4.2.28	Main Condenser Waterboxes, Hatches	Carbon Steel	Open-cycle cooling water (raw water) side	None	None	NUREG-1801 does not address main condenser components. There are no main condenser aging effects requiring management. Therefore, no aging management is required to maintain the intended function of containment holdup plate-out.
3.4.2.29	Accumulators	Stainless Steel	Turbine EHC Fluid	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a turbine EHC fluid environment.
3.4.2.30	NSR Vents or Drains, Piping and Valves	Carbon Steel, Stainless Steel, Brass or Bronze	Air, moisture, humidity, and leaking fluid	Loss of material/ Corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address NSR vents or drains in an air, moisture, humidity and leaking fluid environment.
3.4.2.31	Piping and Fittings	Aluminum	<90°C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.32	Piping and Fittings	Carbon Steel	Generator Hydrogen Seal Oil	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a hydrogen seal oil environment.
3.4.2.33	Piping and Fittings	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address NSR components in the main generator stator cooling environment.
3.4.2.34	Piping and Fittings	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel piping and fittings in a saturated air environment.
3.4.2.35	Piping and Fittings	Stainless Steel	Treated water (BWRs: reactor coolant; PWRs: secondary side water)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address crevice and pitting corrosion of stainless steel in treated water environment.
3.4.2.36	Piping and Fittings	Stainless Steel	Turbine EHC Fluid	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a turbine EHC fluid environment.
3.4.2.37	Pumps	Cast Iron	Generator Hydrogen Seal Oil	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address cast iron components in a generator hydrogen seal oil environment.
3.4.2.38	Pumps	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address NSR components in the main generator stator cooling environment.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.39	Tanks	Aluminum	<90°C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.
3.4.2.40	Tanks	Aluminum	Outdoor ambient conditions	Loss of material/ Pitting	Structures Monitoring Program (B.1.30)	NUREG-1801 does not address outdoor aluminum storage tanks.
3.4.2.41	Tanks	Aluminum	Outdoor ambient conditions	Cracking/ Stress corrosion cracking	Structures Monitoring Program (B.1.30)	NUREG-1801 does not address outdoor aluminum storage tanks.
3.4.2.42	Tanks	Aluminum	Soil and groundwater	Loss of material/ Pitting	Buried Piping and Tanks Inspection (B.1.25)	NUREG-1801 does not address outdoor aluminum tanks resting on the ground (tank bottom).
3.4.2.43	Tanks	Carbon Steel	Generator Hydrogen Seal Oil	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a generator hydrogen seal oil environment.
3.4.2.44	Tanks	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address NSR components in the main generator stator cooling environment.
3.4.2.45	Thermowells	Aluminum	<90°C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.
3.4.2.46	Tubing	Aluminum	<90°C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.47	Tubing	Stainless Steel	Treated water (BWRs: reactor coolant; PWRs: secondary side water)	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address crevice and pitting corrosion of stainless steel in treated water environment.
3.4.2.48	Tubing	Stainless Steel	Turbine EHC Fluid	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a turbine EHC fluid environment.
3.4.2.49	Valves	Aluminum	<90°C (<194°F) treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2)	NUREG-1801 does not address aluminum in a reactor grade water environment.
3.4.2.50	Valves	Carbon Steel	Generator Hydrogen Seal Oil	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address carbon steel components in a generator hydrogen seal oil environment.
3.4.2.51	Valves	Stainless Steel	288°C (550°F) steam	Crack initiation and growth/ Stress corrosion cracking intergranular stress corrosion cracking	Water Chemistry (B.1.2)	NUREG-1801 does not address crevice and pitting corrosion of stainless steel in treated water environment.
3.4.2.52	Valves	Stainless Steel	Demineralized Water - Stator Liquid Cooling	Loss of material/ Pitting and crevice corrosion	Main Generator Stator Cooling Water Chemistry (B.2.7)	NUREG-1801 does not address NSR components in the main generator stator cooling environment.

Table 3.4-2 Aging management review results for the steam and power conversion system that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.4.2.53	Valves	Stainless Steel	Saturated air	Loss of material/ Pitting and crevice corrosion	Compressed Air Monitoring (B.1.16)	NUREG-1801 does not address stainless steel components in a saturated air environment.
3.4.2.54	Valves	Stainless Steel	Treated water	Loss of material/ Pitting and crevice corrosion	Water Chemistry (B.1.2) and One-Time Inspection (B.1.23)	NUREG-1801 does not address crevice and pitting corrosion of stainless steel in treated water environment.
3.4.2.55	Valves	Stainless Steel	Turbine EHC Fluid	Loss of material/ Pitting and crevice corrosion	One-Time Inspection (B.1.23)	NUREG-1801 does not address stainless steel components in a turbine EHC fluid environment.

3.5 AGING MANAGEMENT OF CONTAINMENTS, STRUCTURES AND COMPONENT SUPPORTS

The following tables provide the results of aging management reviews for containments, structures, and component supports component groups within the scope of license renewal for the structures and commodity groups listed below:

- Primary containment
- Reactor building
- Main control room and auxiliary electric equipment room
- Turbine building
- Diesel generator buildings
- Station blackout building and yard structures
- Isolation condenser pump house (Dresden only)
- Makeup demineralizer building (Dresden only)
- Radwaste floor drain surge tank
- Miscellaneous foundations
- Crib house
- Unit 1 crib house (Dresden only)
- Station chimney
- Cranes and hoists
- Component supports commodity group
- Insulation commodity group

Aging management programs and activities are discussed in Appendix B.

The aging management reviews for this section have incorporated the proposed NRC guidance provided in Enclosure 2 to the letter from Christopher I. Grimes, Chief, Licensing and Standardization Branch, Office of Nuclear Reactor Regulation, to Mr. Alan Nelson, Nuclear Energy Institute, "Proposed Staff Guidance on the Position of the GALL Report Presenting One Acceptable Way to Manage Aging Effects for License Renewal," dated November 23, 2001. Table 3.5-1 incorporates revisions provided in Enclosure 2 to this letter.

Components Evaluated Consistent with NUREG-1801

The components or component groups associated with containments, structures and component supports requiring aging management review are presented in Chapter 2. Aging management reviews were performed to assure that the component groups, materials, environments and aging effects referenced in NUREG-1801 are applicable to Dresden and Quad Cities and that the aging management program described in NUREG-1801 is appropriate. The characteristics of the components or component group, the material of construction, and the environment were the determining factors.

When the components or component groups and associated evaluations corresponded with an individual line item in NUREG-1801, Volume 2, the component aging management results were included in the appropriate line items in Table 3.5-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports." Each line in Table 3.5-1 matches a line in Chapter 3 of NUREG-1800, that is applicable to Boiling Water Reactors (BWR) or to both Boiling Water Reactors and Pressurized Water Reactors (BWR/ PWR).

Not all component types in the Dresden and Quad Cities containments, structures and component supports are listed in NUREG-1801, Volume 2. However, the aging management reviews presented in NUREG-1801, Volume 2 were applied to additional component types if the following criteria were satisfied:

- Constructed of the same material as components in the NUREG-1801 line item,
- Assigned the same Component Intended Function as components in the NUREG-1801 line item,
- Located in the same environment as components in the NUREG-1801 line item, and
- Have exhibited the same aging effects identified in the NUREG-1801 line item.

Component types meeting these criteria have been included in the presentation of aging management review results in Table 3.5-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports." The third column of the table shows the component types included in each evaluation line. "NUREG-1801 Components" are those that correspond exactly with component types in NUREG-1801, Volume 2. "Evaluated with NUREG-1801 Components" shows the component types that meet the four (4) criteria above, and therefore share the same evaluation characteristics. Dresden and Quad Cities do not have all of the component types identified in NUREG-1801, Volume 2. The component type entries in the third column of Table 3.5-1 under the "NUREG-1801 Components" heading are those components or component groups that were identified and evaluated at Dresden and Quad Cities.

<u>Other Components Evaluated</u>

Table 3.5-2 "Aging management review results for containments, structures, and component supports that are not addressed in NUREG-1801" presents the aging management review results for the remainder of the containments, structures and component supports components types. These entries result from aging management review results where the component type, material, environment or aging effect/ mechanism differs from NUREG-1801, Volume 2 line item entries. Each line in Table 3.5-2 includes a line reference number, component group, material, environment, aging effect/mechanism, aging management program and discussion.

3.5.1 Aging management programs evaluated in NUREG-1801 that are relied upon for license renewal for containments, structures and component supports.

Table 3.5-1, "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures, and component supports" shows the component groups and aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the containments, structures and component supports.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.1	Penetration sleeves, penetration bellows, and dissimilar metal welds	NUREG-1801 Components Penetration Sleeves Penetration Bellows	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further evaluation of cumulative fatigue damage due to fatigue is provided in Section 3.5.1.1.4 and Section 4.6.
3.5.1.2	Penetration sleeves, bellows, and dissimilar metal welds.	NUREG-1801 Components Containment Penetrations Bellows	Cracking due to cyclic loading, or crack initiation and growth due to SCC	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	Yes, detection of aging effects is to be evaluated	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26. Further evaluation of Cracking due to Cyclic Loading and SCC is described in Section 3.5.1.1.5. CLB fatigue analyses exist for penetration bellows. Therefore, NUREG-1801 line II.B4.1-c does not apply.
3.5.1.3	Penetration sleeves, penetration bellows, and dissimilar metal welds	NUREG-1801 Components Containment Penetrations (Electrical) Containment Penetrations (Mechanical)	Loss of material due to corrosion	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	No	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26.
3.5.1.4	Personnel airlock and equipment hatch	NUREG-1801 Components Hatches	Loss of material due to corrosion	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	No	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26. NUREG-1801, line II.B4.2-a includes "coatings program, if credited." Protective Coating Monitoring and Maintenance (B.1.32) is credited for managing aging effects inside containment.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.5	Personnel airlock and equipment hatch	NUREG-1801 Components Hatches	Loss of leak tightness in closed position due to mechanical wear of locks, hinges and closure mechanism	Containment leak rate test (B.1.28) and Plant Technical Specifications	No	Consistent with NUREG-1801.
3.5.1.6	Seals, gaskets, and moisture barriers	NUREG-1801 Components Seals	Loss of sealant and leakage through containment due to deterioration of joint seals, gaskets, and moisture barriers	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	No	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26.
3.5.1.7	Concrete elements: foundation, walls, dome.	See Discussion Column	Aging of accessible and inaccessible concrete areas due to leaching of calcium hydroxide, aggressive chemical attack, and corrosion of embedded steel	Containment ISI (B.1.26)	Yes, a plant specific aging management program is required for inaccessible areas as stated	Not applicable for a Mark I containment
3.5.1.8	Concrete elements: foundation	See Discussion Column	Cracks, distortion, and increases in component stress level due to settlement	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program	Not applicable for a Mark I containment
3.5.1.9	Concrete elements: foundation	See Discussion Column	Reduction in foundation strength due to erosion of porous concrete subfoundation	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program	Not applicable for a Mark I containment

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.10	Concrete elements: foundation, dome, and wall	See Discussion Column	Reduction of strength and modulus due to elevated temperature	Plant specific	Yes, for any portions of concrete containment that exceed specified temperature limits	Not applicable for a Mark I containment
3.5.1.11	Prestressed containment: tendons and anchorage components	See Discussion Column	Loss of prestress due to relaxation, shrinkage, creep, and elevated temperature	TLAA evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further evaluation of loss of prestress is provided in Section 3.5.1.1.9.
3.5.1.12	Steel elements: liner plate, containment shell	NUREG-1801 Components Downcomers Drywell Heads Drywells Suppression Chambers Evaluated with NUREG-1801 Components Vent Headers Vent Lines	Loss of material due to corrosion in accessible and inaccessible areas	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	Yes, if corrosion is significant for inaccessible areas	Consistent with NUREG-1801, with exception. The exceptions to NUREG-1801 for evaluation of ECCS suction header are described in Section 3.5.1.2.9. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26. Further evaluation of Loss of Material due to Corrosion in Inaccessible Areas of Steel Containment Shell or Liner Plate is described in Section 3.5.1.1.3. NUREG-1801, lines II.B2.1.1-a, II.B2.2.2-a, II.B3.1.1-a, and II.B3.2.2-a do not apply to Mark I containments.
3.5.1.13	Steel elements: vent header, drywell head, torus, downcomers, pool shell	NUREG-1801 Components Suppression Chambers Vent Headers Vent Line Bellows	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further evaluation of cumulative fatigue damage due to fatigue is provided in Section 3.5.1.1.4 and Section 4.6.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.14	Steel elements: protected by coating	NUREG-1801 Components Downcomers Drywell Heads Drywells Suppression Chambers Evaluated with NUREG-1801 Components Vent Headers Vent Lines	Loss of material due to corrosion in accessible areas only	Protective coating monitoring and maintenance (B.1.32)	No	Consistent with NUREG-1801, with exception. The exceptions to NUREG-1801 for evaluation of ECCS suction header are described in Section 3.5.1.2.9. NUREG-1801, lines II.B2.1.1-a, II.B2.2.2-a, II.B3.1.1-a, and II.B3.2.2-a do not apply to Mark I containments.
3.5.1.15	Prestressed containment: tendons and anchorage components	See Discussion Column	Loss of material due to corrosion of prestressing tendons and anchorage components	Containment ISI (B.1.26)	No	Not applicable for a Mark I containment
3.5.1.16	Concrete elements: foundation, dome, and wall	See Discussion Column	Scaling, cracking, and spalling due to freeze-thaw; expansion and cracking due to reaction with aggregate	Containment ISI (B.1.26)	No, if stated conditions are satisfied for inaccessible areas	Not applicable for a Mark I containment

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.17	Steel elements: vent line bellows, vent headers, downcomers	NUREG-1801 Components Vent Line Bellows	Cracking due to cyclic loads or Crack initiation and growth due to SCC	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	Yes, detection of aging effects is to be evaluated	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWE are described in Section B.1.26. Further evaluation of Cracking due to Cyclic Loading and SCC is described in Section 3.5.1.1.5. CLB fatigue analyses exist therefore NUREG-1801 line II.B1.1.1-b (Mark 1 Containment steel elements) does not apply NUREG-1801, lines II.B2.1.1-b, and II.B2.2.2-c do not apply to Mark I containments.
3.5.1.18	Steel elements: Suppression chamber liner	See Discussion Column	Crack initiation and growth due to SCC	Containment ISI (B.1.26) and Containment leak rate test (B.1.28)	No	Not applicable for a Mark I containment
3.5.1.19	Steel elements: drywell head and downcomer pipes	See Discussion Column	Fretting and lock up due to wear	Containment ISI (B.1.26)	No	Material does not exist at Dresden or Quad Cities

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.20	All Groups except Group 6: accessible interior/ exterior concrete & steel components	NUREG-1801 Components Beam Seats Blowout Panels Concrete Beams Concrete Columns Concrete Curbs Concrete Manholes Concrete Shield Plugs Concrete Slabs Concrete Walls Foundations Metal Decking Metal Siding Misc. Steel Penetration Sleeves Precast Concrete Panels Steel Doors Steel Embedments Steel Panels and Cabinets Steel Plates Structural Steel	All types of aging effects	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program and a plant-specific aging management program is required for inaccessible areas as stated	Consistent with NUREG-1801. Further evaluation of Aging of Structures Not Covered by Structures Monitoring Program is described in Section 3.5.1.1.6. Dresden and Quad Cities are Group 2 reactor buildings with steel superstructures NUREG-1801, line III.A2.2-a.) Dresden and Quad Cities do not use stainless steel lined, carbon steel tanks as evaluated in NUREG-1801, line III.A8.2-a. Fuel storage facility, refueling canal identified in NUREG-1801, lines III.A5.1-a,b,c,d,f are evaluated as part of the reactor building in NUREG-1801, lines III.A2.1-a,b,c,d,f. Spent fuel pool identified in NUREG-1801, line III.A5.2-a is evaluated as part of the reactor building in NUREG-1801, line III.A.2.2-a.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.21	Groups 1-3, 5, 7-9: inaccessible concrete components, such as exterior walls below grade and foundation	NUREG-1801 Components Concrete Beams Concrete Columns Concrete Manholes Concrete Slabs Concrete Walls Foundations Evaluated with NUREG-1801 Components Concrete Duct Banks	Aging of inaccessible concrete areas due to aggressive chemical attack, and corrosion of embedded steel	Plant specific	Yes, a plant specific aging management program is required for inaccessible areas as stated	Further evaluation of Aging Management of Inaccessible Areas is described in Section 3.5.1.1.7. Fuel storage facility, refueling canal identified in NUREG-1801, lines III.A5.1-e,g are evaluated as part of the reactor building in NUREG-1801, lines III.A2.1-e,g.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.22	Group 6: all accessible/ inaccessible concrete, steel, and earthen components	NUREG-1801 Components Concrete Curbs Concrete Slabs Concrete Stairs Concrete Walls Foundations Metal Siding Misc. Steel Precast Concrete Panels Steel Embedments Steel Panels and Cabinets Steel Plates Steel Sump Screens Structural Steel Evaluated with NUREG-1801 Components Concrete Canal Weirs	All types of aging effects, including loss of material due to abrasion, cavitation, and corrosion	Inspection of Water-Control Structures (B.1.31) or FERC/ US Army Corps of Engineers dam inspections and maintenance	No	Consistent with NUREG-1801, with exception. The exceptions to structural aging effect for concrete due to settlement are described in Section 3.5.1.2.1. The exceptions to structural aging effect due to freeze-thaw are described in Section 3.5.1.2.2. The exceptions to structural aging effect due to leaching of calcium hydroxide are described in Section 3.5.1.2.3. The exceptions to structural aging effect due to reaction with aggregates are described in Section 3.5.1.2.4. The exceptions to structural aging effect due to abrasion and cavitation are described in Section 3.5.1.2.5. The exceptions to structural aging effects due to corrosion of embedded steel are described in Section 3.5.1.2.6. The exceptions to structural aging effects due to aggressive chemical attack are described in Section 3.5.1.2.7. Earthen water control structures evaluated in NUREG-1801, line III.A6.4-a are not in the scope of license renewal.
3.5.1.23	Group 5: liners	NUREG-1801 Components Liners	Crack initiation and growth from SCC and loss of material due to crevice corrosion	Water Chemistry Program (B.1.2) and Monitoring of spent fuel pool water level	No	Consistent with NUREG-1801.
3.5.1.24	Groups 1-3, 5, 6: all masonry block walls	NUREG-1801 Components Masonry Walls	Cracking due to restraint, shrinkage, creep, and aggressive environment	Masonry Wall (B.1.29)	No	Consistent with NUREG-1801. Fuel storage facility, refueling canal identified in NUREG-1801, line III.A5.3-a are evaluated as part of the reactor building in NUREG-1801, line III.A2.3-a.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.25	Groups 1-3, 5, 7-9: foundation	NUREG-1801 Components Concrete Slabs Foundations	Cracks, distortion, and increases in component stress level due to settlement	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program	Consistent with NUREG-1801. Further evaluation of Cracking, Distortion, and Increase in Component Stress Level due to Settlement; Reduction of Foundation Strength due to Erosion of Porous Concrete Subfoundations is described in Section 3.5.1.1.1. Fuel storage facility, refueling canal identified in NUREG-1801, lines III.A5.1-h is evaluated as part of the reactor building in NUREG-1801, lines III.A2.1-h.
3.5.1.26	Groups 1-3, 5-9: foundation	NUREG-1801 Components Concrete Slabs Foundations	Reduction in foundation strength due to erosion of porous concrete subfoundation	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program	Consistent with NUREG-1801. Further evaluation of Cracking, Distortion, and Increase in Component Stress Level due to Settlement; Reduction of Foundation Strength due to Erosion of Porous Concrete Subfoundations is described in Section 3.5.1.1.1. Fuel storage facility, refueling canal identified in NUREG-1801, lines III.A5.1-i is evaluated as part of the reactor building in NUREG-1801, lines III.A2.1-i.
3.5.1.27	Groups 1-5: concrete	NUREG-1801 Components Concrete Beams Concrete Columns Concrete Slabs Concrete Walls Foundations	Reduction of strength and modulus due to elevated temperature	Plant specific	Yes, for any portions of concrete that exceed specified temperature limits	Further evaluation of Reduction of Strength and Modulus of Concrete Structures due to Elevated Temperature is described in Section 3.5.1.1.2. Fuel storage facility, refueling canal identified in NUREG-1801, lines III.A5.1-j is evaluated as part of the reactor building in NUREG-1801, lines III.A2.1-j.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.28	Groups 7, 8: liners	NUREG-1801 Components Liners	Crack Initiation and growth due to SCC; Loss of material due to crevice corrosion	Plant specific	Yes	The exceptions to NUREG-1801 for cracking due to crack initiation and growth due to SSC and loss of material due to crevice corrosion are described in Section 3.5.1.2.8. Dresden and Quad Cities do not use steel tanks lined with stainless as identified in NUREG-1801, line III.A8.2-b.
3.5.1.29	All Groups: support members: anchor bolts, concrete surrounding anchor bolts, welds, grout pad, bolted connections, etc.	NUREG-1801 Components Anchorage to Buildings, Including Bolted/ Welded Connections Concrete & Grout Instrument Racks, Frames, Panels, Etc, Support Members Vibration Isolation Elements Evaluated with NUREG-1801 Components Raceways	Aging of component supports	Structures Monitoring (B.1.30)	No, if within the scope of the applicant's structures monitoring program	Consistent with NUREG-1801.
3.5.1.30	Groups B1.1, B1.2, and B1.3: support members: anchor bolts, welds	NUREG-1801 Components Anchorage to Buildings, Including Bolted/ Welded Connections	Cumulative fatigue damage (CLB fatigue analysis exists)	TLAA evaluated in accordance with 10 CFR 54.21(c)	Yes, TLAA	Further evaluation of cumulative fatigue damage due to fatigue is provided in Section 3.5.1.1.8 and Section 4.6.

Table 3.5-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for containments, structures and component supports (Continued)

Ref No	Component	Components Evaluated	Aging Effect/ Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.5.1.31	Groups B1.1, B1.2, and B1.3: support members: anchor bolts, welds, guides, stops, and vibration isolators	NUREG-1801 Components Sliding Surfaces Support Members	Loss of material due to environmental corrosion; loss of mechanical function due to corrosion, distortion, dirt, overload, etc.	ISI (B.1.27)	No	Consistent with NUREG-1801, with exception. The exceptions to ASME Section XI, Subsection IWF" are described in Section 3.5.1.2.11.
3.5.1.32	Group B1.1: high strength low-alloy bolts	NUREG-1801 Components Bolting	Crack initiation and growth due to SCC	Bolting integrity (B.1.12)	No	Consistent with NUREG-1801, with exception. The exceptions to bolting integrity are described in Section 3.5.1.2.10. The exceptions to Bolting Integrity are described in Section B.1.12.

3.5.1.1 Further evaluation of aging management as recommended by NUREG-1801 for containments, structures and component supports

3.5.1.1.1 Cracking, Distortion, and Increase in Component Stress Level due to Settlement; Reduction of Foundation Strength due to Erosion of Porous Concrete Subfoundations (NUREG-1800, Section 3.5.2.2.1.2)

Cracks, distortion, increase in component stress level due to settlement are not applicable to Dresden and Quad Cities concrete structures and no aging management is required. The Dresden and Quad Cities licensing basis does not include a program to monitor concrete for settlement nor is a de-watering system in place. Dresden and Quad Cities structures are founded on rock or naturally compacted soil with no documented changes in groundwater conditions or a history of settlement.

Reduction in foundation strength, cracking, and differential settlement due to erosion of porous concrete subfoundation are not applicable to Dresden and Quad Cities and no aging management is required. Dresden and Quad Cities evaluations of Information Notices 97-11 and 98-26 concluded that no porous materials were used. The Dresden and Quad Cities licensing basis does not include a program to monitor concrete for settlement nor is a de-watering system in place. Dresden and Quad Cities structures are founded on rock or natural compacted soil and there is no documented change in groundwater conditions or history of settlement.

3.5.1.1.2 Reduction of Strength and Modulus of Concrete Structures due to Elevated Temperature (NUREG-1800, Section 3.5.2.2.1.3)

Reduction of strength and modulus due to elevated temperature are not applicable for Dresden and Quad Cities concrete structures and no aging management is required. Dresden and Quad Cities normal operating temperatures are less than 150°F general and are less than 200°F local.

3.5.1.1.3 Loss of Material due to Corrosion in Inaccessible Areas of Steel Containment Shell or Liner Plate (NUREG-1800, Section 3.5.2.2.1.4)

Corrosion of containment steel elements in inaccessible areas will be confirmed as insignificant in accordance with aging management program ASME Section XI, Subsection IWE (B.1.26.)

Since Dresden Unit 3 had more water leakage in the sand pocket area than Quad Cities and Dresden Unit 2, UT examinations were performed on Dresden Unit 3 sand pocket area in 1988. The examinations indicated that significant corrosion was not occurring, and it was concluded that corrosion is insignificant at Dresden Unit 2 and Quad Cities as well. A UT examination of the same locations at Dresden Unit 3 is conducted as an augmented inspection in accordance with aging management program ASME Section XI, Subsection IWE (B.1.26) to confirm that significant corrosion is not occurring.

A general visual inspection of the moisture barrier at the junction of the steel drywell shell and the concrete floor is performed once each inspection period in accordance with aging management program ASME Section XI, Subsection IWE (B.1.26.)

Dresden and Quad Cities documentation demonstrates that concrete meeting the requirements of ACI 318-63 and the guidance of ACI 201.2R-77 was used for the concrete in contact with the embedded drywell shell at the sand pocket location. The concrete is monitored for penetrating cracks that provide a path for water seepage in accordance with Structures Monitoring Program (B.1.30.)

3.5.1.1.4 Cumulative Fatigue Damage (NUREG-1800, Section 3.5.2.2.1.6)

Fatigue analyses of BWR Mark I and Mark II containment steel elements, penetration sleeves, and penetration bellows are TLAAs as defined in 10 CFR 54.3. Dresden and Quad Cities are Mark I containments. Cumulative fatigue damage of BWR Mark I containment steel elements, penetration sleeves, and penetration bellows are required to be evaluated in accordance with 10 CFR 54.21(c). The TLAA evaluation of cumulative fatigue damage is addressed in Section 4.6.

3.5.1.1.5 Cracking due to Cyclic Loading and SCC (NUREG-1800, Section 3.5.2.2.1.7)

For Mark 1 Containment steel elements and stainless steel containment penetrations (NUREG-1801 Items II.B1.1.1-d, and II.B4.1-d), stress corrosion cracking (SCC) is a concern for dissimilar metal welds, exposed to a corrosive environment. These components are in a sheltered environment, outside containment and inside the reactor building and are not exposed to a corrosive environment. Therefore, existing requirements for Appendix J leak rate testing (B.1.28) and Containment ISI plan surface inspections, in accordance with ASME Section XI, Subsection IWE (B.1.26), are adequate to detect cracking. In addition, other factors associated with SCC with regard to temperature, pressure and concentrated chlorides are not at threshold levels at the installed locations.

ASME Section XI, Subsection IWE weld examination categories E-B and E-F have been removed from the ASME Section XI, 1998 Edition. Both of these weld categories are considered to be part of the containment boundary surface in the current Dresden Containment Inservice Inspection (CISI) Program (ASME Section XI, Subsection IWE 1998 Edition) and Quad Cities CISI Programs and are subject to the examination requirements of Category E-A.

3.5.1.1.6 Aging of Structures Not Covered by Structures Monitoring Program (NUREG-1800, Section 3.5.2.2.2.1)

Structures Monitoring Program (B.1.30) is required to manage the following structural aging effects for accessible areas:

- Loss of material and cracking due to freeze-thaw of concrete.
- Increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete.
- Increase in porosity and permeability, cracking, and loss of material (spalling, scaling) due to aggressive chemical attack of concrete.
- Expansion and cracking due to reaction with aggregates of concrete.

- Cracking, loss of bond, and loss of material (spalling, scaling) due to corrosion of embedded steel of concrete.

No aging management is required to manage the following structural aging effects for inaccessible areas.

- Loss of material and cracking due to freeze-thaw of concrete.

For loss of material and cracking due to freeze-thaw of concrete in inaccessible areas, no aging management is required. Dresden and Quad Cities are located in severe weathering conditions. Dresden and Quad Cities have documented evidence to show that the concrete air content is between 3% and 6%. Plant inspections did not show freeze-thaw degradation. Therefore, loss of material and cracking due to freeze-thaw of concrete in inaccessible areas are not applicable and no aging management is required.

- Increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete.

For increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete in inaccessible areas, no plant-specific aging management is required. Dresden and Quad Cities concrete is not exposed to flowing water and there is documented evidence that the concrete used was constructed in accordance with the recommendations in ACI 201.2R-77 for durability. Therefore, increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete in inaccessible areas are not applicable and no plant-specific aging management is required.

- Expansion and cracking due to reaction with aggregates of concrete.

For expansion and cracking due to reaction with aggregates of concrete in inaccessible areas, no aging management is required. Dresden and Quad Cities documented evidence demonstrates that the concrete used meets the requirements of ACI 201.2R-77 with no evidence of reactive aggregates. Therefore, expansion and cracking due to reaction with aggregates of concrete in inaccessible areas are not applicable and no aging management is required.

- Loss of Material in Drywell Radial Beam Lubrite Baseplates

Aging management of loss of material due to galvanic corrosion, lock-up or wear of lubrite baseplates will be performed by One-Time Inspection (B.1.23) The torus saddle support lubrite baseplates will be visually inspected to verify unacceptable loss of material due to galvanic corrosion, lock-up or wear has not occurred. The drywell radial beam lubrite baseplates and torus saddle support lubrite baseplates are comprised of the same materials and are exposed to similar environments. The drywell radial beam lubrite baseplates are not accessible for inspection; therefore the inspection of the torus saddle support lubrite baseplates will be used as a representative inspection for aging of the drywell radial beam lubrite baseplates.

3.5.1.1.7 Aging Management of Inaccessible Areas (NUREG-1800, Section 3.5.2.2.2.2)

No plant-specific aging management is required to manage the following structural aging effects for inaccessible areas:

- Increase in porosity and permeability, cracking, and loss of material (spalling, scaling) due to aggressive chemical attack of concrete.
- Cracking, loss of bond, and loss of material (spalling, scaling) due to corrosion of embedded steel of concrete.

Dresden and Quad Cities ground water test data obtained during construction, the 1980's, 1990's, and 2000's shows that the below-grade environment is not aggressive based on NUREG-1801 criteria with chlorides less than 500 ppm, sulfates less than 1500 ppm, and pH greater than 5.5. Examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of the Structures Monitoring Program (B.1.30.) To ensure conditions are maintained throughout the period of extended operations, the Structures Monitoring Program (B.1.30) will be enhanced to include monitoring of below-grade water chemistry to demonstrate that the environment remains non-aggressive. Existing plant procedures will be used to periodically sample pH, chlorides, and sulfates.

3.5.1.1.8 Cumulative Fatigue Damage due to Cyclic Loading (NUREG-1800, Section 3.5.2.2.3.2)

Fatigue of component support members, anchor bolts, and welds for Groups B1.1, B1.2, and B1.3 component supports is a TLAA as defined in 10 CFR 54.3 only if a CLB fatigue analysis exists. Dresden and Quad Cities piping and component supports were designed to ASME Section VIII and ANSI USAS B31.1. Dresden Unit 3 ASME III Class I replacement piping was analyzed to Subsection NB, 1980 Edition including Summer 1982 Addenda. None of these codes required formal fatigue analysis of supports or design of supports for fatigue effects. Some ASME III Class MC support components were the subject of fatigue analysis in support of the Mark I "New Loads" program. Cumulative fatigue damage of ASME III Class MC support components are required to be evaluated in accordance with 10 CFR 54.21(c)(1). The TLAA evaluation of the ASME III Class MC support components is addressed in Section 4.6.

3.5.1.1.9 Loss of Prestress due to Relaxation, Shrinkage, Creep, and Elevated Temperature (NUREG-1800, Section 3.5.2.2.1.5)

Loss of prestress forces due to relaxation, shrinkage, creep, and elevated temperature for PWR prestressed concrete containments and BWR Mark II prestressed concrete containments is a TLAA as defined in 10 CFR 54.3. Loss of prestress is not applicable to Dresden and Quad Cities Mark I containments.

3.5.1.2 Aging management programs or evaluations that are different than those described in NUREG-1801 for structures and component supports

3.5.1.2.1 Exception to structural aging effect for concrete due to settlement

The Dresden and Quad Cities licensing basis does not include a program to monitor concrete for settlement nor is a de-watering system in place. Dresden and Quad Cities structures are founded on rock or naturally compacted soil with no documented changes in groundwater conditions or a history of settlement. Cracks, distortion and increase in component stress level due to settlement are not applicable and no aging management is required.

3.5.1.2.2 Exception to structural aging effect due to freeze-thaw

For loss of material and cracking due to freeze-thaw of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For loss of material and cracking due to freeze-thaw of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities are located in severe weathering conditions. Dresden and Quad Cities have documented evidence to show that the concrete air content is between 3% and 6%. Plant inspections did not show freeze-thaw degradation. Therefore, loss of material and cracking due to freeze-thaw of concrete in inaccessible areas are not applicable and no aging management is required.

3.5.1.2.3 Exception to structural aging effect due to leaching of calcium hydroxide

For increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities concrete is not exposed to flowing water and there is documented evidence that the concrete used was constructed in accordance with the recommendations in ACI 201.2R-77 for durability. Therefore, increase in porosity and permeability and loss of strength due to leaching of calcium hydroxide of concrete in inaccessible areas are not applicable and no plant-specific aging management is required.

3.5.1.2.4 Exception to structural aging effect due to reaction with aggregates

For expansion and cracking due to reaction with aggregates of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For expansion and cracking due to reaction with aggregates of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities documented evidence demonstrates that the concrete used meets the requirements of ACI 201.2R-77 with no evidence of reactive aggregates.

Therefore, expansion and cracking due to reaction with aggregates of concrete in inaccessible areas are not applicable and no aging management is required.

3.5.1.2.5 Exception of structural aging effect due to abrasion and cavitation

For loss of material due to abrasion and cavitation of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For loss of material due to abrasion and cavitation of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities water velocity at 3.68 feet per second (fps) is less than the industry abrasion erosion threshold velocity of 4 fps and less than the industry cavitation threshold velocity of 25 fps. Therefore, loss of material due to abrasion and cavitation of concrete in inaccessible areas is not applicable and no aging management is required.

3.5.1.2.6 Exception of structural aging effects due to corrosion of embedded steel

For cracking, loss of bond, and loss of material (spalling, scaling) due to corrosion of embedded steel of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For cracking, loss of bond, and loss of material (spalling, scaling) due to corrosion of embedded steel of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities ground water test data obtained during construction, the 1980's, 1990's, and 2000's shows that the below-grade environment is not aggressive based on NUREG-1801 criteria with chlorides less than 500 ppm, sulfates less than 1500 ppm, and pH greater than 5.5.

Examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of the Structures Monitoring Program (B.1.30.)

To ensure conditions are maintained throughout the period of extended operations, the Structures Monitoring Program (B.1.30) will be enhanced to include monitoring of below-grade water chemistry to demonstrate that the environment remains non-aggressive. Existing plant procedures will be used to periodically sample pH, chlorides, and sulfates.

3.5.1.2.7 Exception of structural aging effects due to aggressive chemical attack

For increase in porosity and permeability, cracking, and loss of material (spalling, scaling) due to aggressive chemical attack of concrete in accessible areas, the aging management program is RG 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants (B.1.31.)

For increase in porosity and permeability, cracking, and loss of material (spalling, scaling) due to aggressive chemical attack of concrete in inaccessible areas, no aging management is required.

Dresden and Quad Cities ground water test data obtained during construction, the 1980's, 1990's, and 2000's shows that the below-grade environment is not aggressive based on NUREG-1801 criteria with chlorides less than 500 ppm, sulfates less than 1500 ppm, and pH greater than 5.5.

Examination of representative samples of below-grade concrete, when excavated for any reason, is included as part of the Structures Monitoring Program (B.1.30.)

To ensure conditions are maintained throughout the period of extended operations, the Structures Monitoring Program (B.1.30) will be enhanced to include monitoring of below-grade water chemistry to demonstrate that the environment remains non-aggressive. Existing plant procedures will be used to periodically sample pH, chlorides, and sulfates.

3.5.1.2.8 Exception to NUREG-1801 for cracking due to crack initiation and growth due to SSC and loss of material due to crevice corrosion

Stainless steel liners in the Dresden and Quad Cities floor drain surge tanks are not susceptible to cracking due to crack initiation and growth due to SSC or loss of material due to crevice corrosion and do not require aging management.

The floor drain surge tanks are vented and constructed of reinforced concrete with a stainless steel liner. The floor drain surge tank liner is not considered susceptible to SCC, since the tanks are vented (low service pressure), concentrated chlorides in the effluent are not expected, and the temperature of effluents would be ambient (less than threshold temperature of 140 degrees F for SCC). Stainless steel is susceptible to crevice corrosion given a sufficiently narrow crevice in the presence of oxygen. Crevice corrosion most frequently occurs in joints, and connections, or points of contact between metals and nonmetals, such as gasket surfaces, lap joints, and under bolt heads where contaminants can concentrate. The stainless steel liner has all welded seams and plug welds for anchorage, with all welds ground smooth. Therefore, the occurrence of crevice corrosion in the tank liner is not expected due to its configuration.

In addition, the floor drain surge tank has a drain system installed between the liner and concrete that would intercept leakage from behind the liner plate weld seams and drain the leakage to the attached pump house room. There have been no documented corrective action requests related to aging associated with the stainless steel liner plate drains.

3.5.1.2.9 Exception to NUREG-1801 for evaluation of ECCS Suction Header

For the evaluation of the ECCS suction header, an exception is taken to NUREG-1801 for item II.B.1.1.1-a. The ECCS suction header piping and fittings connected to the suppression chamber are evaluated with NUREG-1801 line V.D2.1.a (lines to suppression chamber) with the results presented in Table 3.2-1, reference numbers 3.2.1.2 and 3.2.1.4.

3.5.1.2.10 Exception to GALL for XI.M18, "Bolting Integrity"

Dresden and Quad Cities recirculation piping loop component supports inside the containment have ASTM 193 Grade B7 high strength low alloy steel bolting. The specification for ASTM 193 Grade B7 lists minimum yield strength of 105 ksi. with no upper yield strength installed. No documented evidence of cracking of ASTM 193 Grade B7 high strength low alloy steel bolting could be found in the Dresden and Quad Cities recirculation piping loop component supports operating experience data. Therefore, aging management of support members, including bolted connections for Class I piping and components will be managed by aging management program ASME Section XI, Subsection IWF (B.1.27.)

3.5.1.2.11 Exception to GALL for XI.S3, "ASME Section XI, Subsection IWF"

Aging of downcomer bracing will be managed with the inspections performed by the aging management program ASME Section XI, Subsection IWE (B.1.26.)

3.5.2 Components or aging effects that are not addressed in NUREG-1801 for the containments, structures and component supports

Table 3.5-2, "Aging management review results for containments, structures, and component supports that are not addressed in NUREG-1801" contains aging management review results for the containments, structures, and component supports that are not addressed in NUREG-1801.

Table 3.5-2 Aging management review results for containments, structures, and component supports that are not addressed in NUREG-1801

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.5.2.1	Bus Duct Covers	Galvanized or Coated Carbon Steel	Weather exposed	Loss of material/ General corrosion	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address offsite power structures for coping with SBO.
3.5.2.2	Bus Duct Supports	Galvanized or Coated Carbon Steel	Weather exposed	Loss of material/ General corrosion	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address offsite power structures for coping with SBO.
3.5.2.3	Caulking/ Sealants	Silicone Rubber	Various	Hardening cracking/ Elastomer degradation	Structures Monitoring Program (B.1.30)	NUREG-1801 does not address caulking/ sealants used with turbine building water tight doors.
3.5.2.4	Caulking/ Sealants	Silicone Rubber	Weather exposed	Change in Material Properties/ Loss of resiliency, loss of strength, loss of elasticity	Structures Monitoring Program (B.1.30)	NUREG-1801 does not have this component.
3.5.2.5	Clevis Pins: Torus Columns, Vent Systems, ESF Lines	Carbon Steel or Stainless Steel	Submerged (torus grade water) and inside or outside containment	Loss of Material/ Mechanical wear	ASME Section XI, Subsection IWF (B.1.27)	Torus support columns applicable to Dresden only. NUREG-1801 does not address mechanical wear of clevis pins.
3.5.2.6	Dead End Structures	Galvanized or Coated Carbon Steel	Weather exposed	Loss of material/ General corrosion	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address offsite power structures for coping with SBO.
3.5.2.7	Door Seals	Silicone Rubber	Various	Hardening cracking/ Elastomer degradation	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address this specific secondary containment pressure boundary component.
3.5.2.8	Drywell Expansion Foam	Polyurethane	Outside containment	Hardening/ Radiation exposure	Time-Limited Aging Analysis evaluated for the period of extended operation	NUREG-1801 does not address line item for drywell air gap fill material. Plant-specific TLAA is described in Section 4.7.4.

Table 3.5-2 Aging management review results for containments, structures, and component supports that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.5.2.9	Masonry Walls	Concrete Block	Various	Cracking/ Restraint; shrinkage; creep; aggressive environment	Masonry Wall Program (B.1.29)	NUREG-1801 does not address these components for a Group 9 structure.
3.5.2.10	New Fuel Racks	Aluminum	Various	None	None	NUREG-1801 does not address aluminum material for new fuel racks. Aluminum is reactive, but develops an aluminum oxide film that protects it from further corrosion. No viable aging effects exist in this indoor environment for the new fuel storage racks.
3.5.2.11	Roofing	Vapor barrier coal tar pitch rigid insulation felt gravel or single ply hypalon pavers	Weather exposed	Separation and water in-leakage/ weathering	Structures Monitoring Program (B.1.30)	NUREG-1801 does not have this component .
3.5.2.12	Secondary Containment Boot Seals	Silicone Rubber	Various	Hardening cracking/ Elastomer degradation	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address this specific secondary containment pressure boundary component.
3.5.2.13	Seismic Gap Filler	Polyethylene	Weather exposed	Change in Material Properties/ Loss of resiliency, loss of strength, loss of elasticity	Structures Monitoring Program (B.1.30)	NUREG-1801 does not have this component.
3.5.2.14	Support Members	Stainless Steel	Inside or outside containment	Loss of material/ Pitting and crevice corrosion	ASME Section XI, Subsection IWF (B.1.27)	NUREG-1801 does not address stainless steel support members. Stainless steel pipe support stanchions are used on the recirc piping 28" lines at Dresden and Quad Cities.

Table 3.5-2 Aging management review results for containments, structures, and component supports that are not addressed in NUREG-1801 (Continued)

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.5.2.15	Thermowells	Stainless Steel; Dissimilar Metal Welds	Inside or outside containment	Loss of material/ General galvanic pitting and crevice corrosion	ASME Section XI, Subsection IWE (B.1.26)	NUREG-1801 does not address stainless steel thermowells installed in torus.
3.5.2.16	Transmission Towers	Galvanized or Coated Carbon Steel	Weather exposed	Loss of material/ General corrosion	Structures Monitoring Program (B.1.30)	NUREG-1801 Chapter III does not address offsite power structures for coping with SBO.

3.6 AGING MANAGEMENT OF ELECTRICAL AND INSTRUMENTATION AND CONTROLS

This section provides the results of aging management reviews for electrical and instrumentation and control components within the scope of license renewal. Aging management programs and activities are discussed in Appendix B.

Components Evaluated Consistent with NUREG-1801

The electrical and instrumentation and control components or component groups requiring aging management review are presented in Section 2.5. Aging management reviews were performed to assure that the component groups, materials, environments and aging effects referenced in NUREG-1801 are applicable to Dresden and Quad Cities and that the aging management program described in NUREG-1801 is applicable to Boiling Water Reactors (BWR) or to both Boiling Water Reactors and Pressurized Water Reactors (BWR/PWR).

When the components or component group and associated evaluations corresponded with an individual line item in NUREG-1801, Volume 2, the component aging management results were included in the appropriate line items in Table 3.6-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the electrical and instrumentation and control components." Each line in Table 3.6-1 matches a line in Chapter 3 of NUREG-1800 that is applicable to Boiling Water Reactors (BWR).

Not all the electrical and instrumentation and control component types at Dresden and Quad Cities are listed in NUREG-1801, Volume 2. However, the aging management reviews presented in NUREG-1801, Volume 2 were applied to additional component types if the following criteria were satisfied:

- Constructed of the similar material as components in the NUREG-1801 line item,
- Assigned the same component intended function as components in the NUREG-1801 line item,
- Located in the same environment as components in the NUREG-1801 line item, and
- Have exhibited the same aging effects identified in the NUREG 1801 line item.

Component types meeting these criteria have been included in the presentation of aging management review results in Table 3.6-1 "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for electrical and instrumentation and control components." The third column of the table shows the component types included in each evaluation line. "NUREG 1801 Components" are those that correspond exactly with component types in NUREG 1801, Volume 2. "Evaluated with NUREG 1801 Components" shows the component types that meet the criteria above, and therefore share the same evaluation characteristics.

Other Components Evaluated

Table 3.6-2, "Aging management review results for the electrical and instrumentation and control components that are not addressed in NUREG-1801" presents the aging management review results for the remainder of the electrical and instrumentation and control components. These entries result from aging management review where the component type, material, environment or aging effect/mechanism differs from NUREG-1801, Volume 2 line item entries. Table 3.6-2 includes a line reference number, component group, material, environment, aging effect/mechanism, aging management program and discussion.

3.6.1 Aging management programs evaluated in NUREG-1801 that are relied upon for license renewal for the electrical and instrumentation and control components.

Table 3.6-1, "Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the electrical and instrumentation and control components" shows the component groups and aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the electrical and instrumentation and control components.

Table 3.6-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the electrical and instrumentation and control components

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.6.1.1	Electrical equipment subject to 10 CFR 50.49 environmental qualification (EQ) requirements	NUREG-1801 Components Electrical Equipment Subject to 10 CFR 50.49 (EQ) Requirements	Degradation due to various aging mechanisms	Environmental qualification of electric components (B.1.35)	Yes, TLAA	Further evaluation of degradation due to various aging mechanisms is provided in Section 3.6.1.1.1 and Section 4.4.
3.6.1.2	Electrical cables and connections not subject to 10 CFR 50.49 EQ requirements	NUREG-1801 Components Electrical Cables Evaluated with NUREG-1801 Components Connectors Fuse Blocks Splices Terminal Blocks	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced insulation resistance (IR); electrical failure caused by thermal/ thermoxidative degradation of organics; radiolysis and photolysis (ultraviolet [UV] sensitive materials only) of organics; radiation-induced oxidation; moisture intrusion	Aging management program for electrical cables and connections not subject to 10 CFR 50.49 EQ requirements (B.1.33)	No	Consistent with NUREG-1801.

Table 3.6-1 Aging management programs evaluated in NUREG-1801 that are relied on for license renewal for the electrical and instrumentation and control components (Continued)

Ref No	Component	Components Evaluated	Aging Effect/Mechanism	Aging Management Program	Further Evaluation Recommended	Discussion
3.6.1.3	Electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements that are sensitive to reduction in conductor insulation resistance (IR)	NUREG-1801 Components Electrical Cables	Embrittlement, cracking, melting, discoloration, swelling, or loss of dielectric strength leading to reduced IR; electrical failure caused by thermal/ thermoxidative degradation of organics; radiation-induced oxidation; moisture intrusion	Aging management program for electrical cables used in instrumentation circuits not subject to 10 CFR 50.49 EQ requirements	No	Consistent with NUREG-1801, with exception. The exceptions to instrumentation cable insulation are described in Section 3.6.1.2.1.
3.6.1.4	Inaccessible medium-voltage (2 kV to 15 kV) cables (e.g., installed in conduit or direct buried) not subject to 10 CFR 50.49 EQ requirements	NUREG-1801 Components Electrical Cables	Formation of water trees, localized damage leading to electrical failure (breakdown of insulation); water trees caused by moisture intrusion	Aging management program for inaccessible medium-voltage cables not subject to 10 CFR 50.49 EQ requirements	No	Consistent with NUREG-1801, with exception. The exceptions to formation of water treeing are described in Section 3.6.1.2.2. Only Dresden has 4160V cables in the scope of license renewal that are routed in underground ducts.

3.6.1.1 Further evaluation of aging management as recommended by NUREG-1801 for the electrical and instrumentation and control components

3.6.1.1.1 Electrical Equipment Subject to Environmental Qualification (NUREG-1800, Section 3.6.2.2.1)

Environmental qualification is a TLAA as defined in 10 CFR 54.3. TLAAs are required to be evaluated in accordance with 10 CFR 54.21(c)(1). Degradation due to various aging mechanisms for electrical equipment subject to 10 CFR 50.49 environmental qualification requirements is evaluated in accordance with 10 CFR 54.21(c)(1). The TLAA evaluation for electrical equipment subject to 10 CFR 50.49 environmental qualification requirements is provided in Section 4.4.

3.6.1.2 Aging management programs or evaluations that are different than those described in NUREG-1801 for the electrical and instrumentation and control components

3.6.1.2.1 Exception to Instrumentation Cable Insulation

Sensitive instrumentation circuit cable insulations were reviewed for their resilience against temperature, radiation and moisture environments. All cable insulation materials were assessed to have 60-year temperature and radiation thresholds greater than the bounding plant environments for which cables and connections are installed. The specified aging effects are not expected and therefore, no aging management is required. However, the cables of sensitive instrumentation circuits not subject to 10 CFR 50.49 requirements will be managed for aging due to adverse localized environments, as they are included in cables that are managed for aging per Item 3.6.1.2 of Table 3.6-1 and aging management program Electrical Cables and Connections Not Subject to 10 CFR 50.49 Environmental Qualification Requirements (B.1.33.)

3.6.1.2.2 Exception to formation of water treeing

Five medium-voltage power cables at Dresden are exposed to significant moisture and significant voltage (subject to system voltage more than 25% of the time). Prior to the extended period of operation, these five medium-voltage power cables will be replaced with cables that are resistant to insulation degradation due to water treeing, and therefore no aging management is required.

3.6.2 Components or aging effects that are not addressed in NUREG-1801 for the electrical and instrumentation and control components

Table 3.6-2, "Aging management review results for the electrical and instrumentation and control components that are not addressed in NUREG-1801" contains aging management review results for the electrical and instrumentation and control components that are not addressed in NUREG-1801.

Table 3.6-2 Aging management review results for the electrical and instrumentation and control components that are not addressed in NUREG-1801

Ref No	Component Group	Material	Environment	Aging Effect/ Mechanism	Aging Management Program	Discussion
3.6.2.1	High Voltage Transmission Conductors	Aluminum Conductor Steel Reinforced	Outdoors: sun, weather, humidity, and moisture	Loss of material/ Corrosion	None	NUREG-1801 does not address aluminum conductor. The plant outdoor environment is not subject to heavy industry air pollution or saline environment. Aluminum is reactive, but develops an aluminum oxide film that protects it from further corrosion.
3.6.2.2	Insulators	Polyester Glass	Indoor and outdoor environments	Embrittlement cracking melting discoloration swelling or loss of dielectric strength leading to reduced insulation resistance electrical failure	Periodic Visual Inspection of Electrical Bus Duct Insulation (B.2.2)	NUREG-1801 does not address polyester glass.
3.6.2.3	Insulators	Porcelain	Indoor and outdoor environments	None	None	NUREG-1801 does not address porcelain. The plant outdoor environment is not subject to heavy industrial air pollution or saline environment. Plant indoor and outdoor environments are not conducive to promoting aging degradation of porcelain components.

CHAPTER 4
TIME-LIMITED AGING ANALYSES

List of Tables

4.0 TIME-LIMITED AGING ANALYSES

4.1 INTRODUCTION

This chapter presents descriptions of the Time-Limited Aging Analyses (TLAAs) for Dresden and Quad Cities in accordance with 10 CFR 50.34(a) and 54.21(c). The chapter is divided into sections, each containing a number of TLAAs on a common general category:

- Neutron Embrittlement of the Reactor Vessel and Internals
- Metal Fatigue of the Reactor Vessel, Internals, and Primary Coolant Boundary Piping and Components
- Environmental Qualification of Electrical Equipment (EQ)
- Loss of Prestress in Concrete Containment Tendons
- Fatigue of the Primary Containment, Attached Piping, and Components
- Other Plant-Specific TLAAs

Information about the TLAAs in a general category is presented within each section, as follows:

Applicability:	The plants to which this TLAA applies are identified.
Summary Description:	A brief description of the TLAA topic is provided.
Analysis:	A description of the current license analysis is provided.
Disposition:	The disposition is provided and classified in accordance with 10 CFR 54.21(c)(1) as: ▪ Validation, ▪ Revision, or ▪ Aging Management

NUREG-1801 identifies numerous aging effects that require evaluation as possible TLAAs in accordance with 10 CFR 54.21(c). Each of these is summarized in NUREG-1800 and presented in Section 3 of this LRA and referenced to the appropriate TLAA section.

4.1.1 Identification of TLAAs

The scope and methods for identifying TLAAs are consistent with the NUREG-1800 *Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants.* (SRP)

Under the 10 CFR 54 License Renewal Rule (the Rule), an analysis, calculation, or evaluation is a "Time-Limited Aging Analysis" (TLAA) only if it meets all six of the defining criteria per 10 CFR 54.3(a). These are:

(1) Involve systems, structures, and components within the scope of license renewal,

(2) Consider the effects of aging;
(3) Involve time-limited assumptions defined by the current operating term, for example, 40 years;
(4) Were determined to be relevant by the licensee in making a safety determination;
(5) Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, and component to perform its intended functions, and
(6) Are contained or incorporated by reference in the CLB (current licensing basis).

A list of potential generic TLAAs was assembled from the SRP, industry guidance and experience, including

- The NUREG-1800 *Standard Review Plan for License Renewal*
- The NEI 95-10 *Industry Guideline for Implementing the Requirements of 10 CFR 54 the License Renewal Rule*
- The 10 CFR 54 Final Rule "Statement of Considerations," and
- Prior license renewal applications.

The Dresden and Quad Cities current licensing basis (CLB) was searched to confirm the occurrence of plant-specific TLAAs and to identify additional unit-specific TLAAs. The CLB search included the following documents:

- Updated Final Safety Analysis Reports (UFSARs)
- Operating License and License Conditions
- Technical Specifications
- Technical Requirements Manuals
- Safety Evaluation Reports (SERs)
- Exelon and NRC Licensing Correspondence
- Licensing basis program documents, such as the ISI and EQ.

The resulting list of potential TLAAs was reviewed (screened) against the six 10 CFR 54.3(a) criteria with the aid of supporting documents, such as:

- Environmental Qualification Binders
- ISI reports (ASME XI Summaries of Reportable Indications)
- Design Basis Documents
- Drawings
- Specifications
- Calculations
- Containment Plant Unique Analysis Report (PUAR)
- Procedures
- Supporting databases.

The supporting sources confirmed the screening and provided the information needed for dispositions.

The Rule requires that these TLAAs be evaluated to demonstrate that

(i) The analyses remain valid for the period of extended operation;
(ii) The analyses have been projected to the end of the period of extended operation; or
(iii) The effects of aging on the intended function(s) will be adequately managed for the period of extended operation.

Each TLAA was dispositioned by one of these three methods.

4.1.2 Identification of Exemptions

The rule requires a list of plant-specific exemptions granted pursuant to 10 CFR 50.12 and is based on time-limited aging analyses as defined in §54.3.

A search of docketed correspondence, the operating licenses, and the Updated Final Safety Analysis Reports (UFSARs) was made to identify all exemptions in effect. Each exemption in effect was evaluated to determine if it involved a TLAA as defined in 10 CFR 54.3. There are no exemptions based on time-limited aging analyses in effect.

4.1.3 Summary of Results

Six general categories of TLAAs applicable to Dresden and Quad Cities were identified in Sections 4.2 through 4.7 of this chapter, with their dispositions. A summary is presented in Table 4.1-1. The table includes a reference to the applicable section of this report that discusses the TLAA.

Table 4.1-1: List of Time-Limited Aging Analyses (TLAAs)

TLAA	Description	Applies to	Disposition Category	Section
1.	Neutron Embrittlement of the Reactor Vessel and Internals			4.2
	Reactor Vessel Materials Upper-Shelf Energy Reduction Due to Neutron Embrittlement	Dresden and Quad Cities	Revision of the analysis	4.2.1
	Adjusted Reference Temperature for Reactor Vessel Materials Due to Neutron Embrittlement	Dresden and Quad Cities	Revision of the analysis	4.2.2
	Reflood Thermal Shock Analysis of the Reactor Vessel	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.2.3
	Reflood Thermal Shock Analysis of the Reactor Vessel Core Shroud and Repair Hardware	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.2.4
	Reactor Vessel Thermal Limit Analysis: Operating Pressure – Temperature Limits	Dresden and Quad Cities	Revision of the analysis	4.2.5
	Reactor Vessel Circumferential Weld Examination Relief	Dresden only	Revision of the analysis	4.2.6
	Reactor Vessel Axial Weld Failure Probability	Dresden only	Revision of the analysis	4.2.7
2.	Metal Fatigue of the Reactor Vessel, Internals, and Reactor Coolant Pressure Boundary Piping and Components			4.3
	Reactor Vessel Fatigue Analyses	Dresden and Quad Cities	Management of the aging effect	4.3.1
	Fatigue Analysis of Reactor Vessel Internals			4.3.2
	Low-Cycle Thermal Fatigue Analyses of the Core Shroud and Repair Hardware	Quad Cities only	Validation of the analysis for the period of extended operation	4.3.2.1
	High-Cycle Flow-Induced Vibration Fatigue Analysis of Jet Pump Riser Braces	Dresden only	Revision of the analysis (repair)	4.3.2.2

Table 4.1-1: List of Time-Limited Aging Analyses (TLAAs) (Continued)

TLAA	Description	Applies to	Disposition Category	Section
	Reactor Coolant Pressure Boundary Piping and Component Fatigue Analysis			4.3.3
	ASME Section III Class I Reactor Coolant Pressure Boundary Piping and Component Fatigue Analysis	Dresden only	Management of the aging effect	4.3.3.1
	Reactor Coolant Pressure Boundary Piping and Components Designed to B31.1, ASME Section III Class 2 and 3, or ASME Section VIII Class B and C	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.3.3.2
	Fatigue Analysis of the Isolation Condenser	Dresden only	Validation of the analysis for the period of extended operation	4.3.3.3
	Effects of Reactor Coolant Environment on Fatigue Life of Components and Piping (Generic Safety Issue 190)	Dresden and Quad Cities	Revision of the analysis	4.3.4
3.	Environmental Qualification of Electrical Equipment (EQ)	Dresden and Quad Cities	Management of the aging effect	4.4
4.	Loss of Prestress in Concrete Containment Tendons (The Dresden and Quad Cities containments have no prestress tendons.)	NA	Not applicable	4.5
5.	Fatigue of the Primary Containment, Attached Piping, and Components			4.6
	Fatigue Analyses of the Suppression Chamber, Vents, and Downcomers	Dresden and Quad Cities	Validation of the analysis for the period of extended operation, and Management of the aging effect	4.6.1

Table 4.1-1: List of Time-Limited Aging Analyses (TLAAs) (Continued)

TLAA	Description	Applies to	Disposition Category	Section
	Fatigue Analysis of SRV Discharge Piping Inside the Suppression Chamber, External Suppression Chamber Attached Piping, and Associated Penetrations	Dresden and Quad Cities	Validation of the analysis for the period of extended operation, and Management of the aging effect	4.6.2
	Drywell-to-Suppression Chamber Vent Line Bellows Fatigue Analyses	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.6.3
	Primary Containment Process Penetration Bellows Fatigue Analysis	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.6.4
6.	Other Plant-Specific TLAAs			4.7
	Reactor Building Crane Load Cycles	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.7.1
	Metal Corrosion			4.7.2
	Corrosion Allowance for Power Operated Relief Valves	Quad Cities only	Validation of the analysis for the period of extended operation	4.7.2.1
	Degradation Rates of Inaccessible Exterior Drywell Plate Surfaces	Dresden and Quad Cities	Revision of the analysis	4.7.2.2
	Galvanic Corrosion in the Containment Shell and Attached Piping Components due to Stainless Steel ECCS Suction Strainers	Dresden and Quad Cities	Revision of the analysis	4.7.2.3
	Crack Growth Calculation of a Postulated Flaw in the Heat Affected Zone of an Arc Strike in the Suppression Chamber Shell	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.7.3
	Radiation Degradation of Drywell Shell Expansion Gap Polyurethane Foam	Dresden and Quad Cities	Validation of the analysis for the period of extended operation	4.7.4
	High-Energy Line Break Postulation Based on Fatigue Cumulative Usage Factor (Usage factors were not used in the break location criteria for these plants.)	NA	Not applicable	4.7.5

4.2 NEUTRON EMBRITTLEMENT OF THE REACTOR VESSEL AND INTERNALS

The ferritic materials of the reactor vessel are subject to embrittlement due to high energy neutron exposure. Embrittlement means the material has lower toughness (e.g. will absorb less strain energy during a crack or rupture), thus allowing a crack to propagate more easily under load.

Toughness (indirectly measured in foot-pounds of absorbed energy in a Charpy impact test) is temperature dependent. In most materials, toughness increases with temperature up to a maximum value called the "upper-shelf energy," or USE. Neutron embrittlement results in a decrease to the USE of reactor vessel steels. To reduce the potential for brittle fracture during vessel operation, account for the changes in material toughness as a function of neutron radiation exposure (fluence), and account for a reduction in toughness, operating pressure-temperature limit curves (P-T curves) are included in plant Technical Specifications. The P-T curves account for the decrease in material toughness associated with a given fluence in the future. The fluence is used to predict the loss in toughness of the reactor vessel materials. Based on the projected drop in toughness for a given fluence, the P-T curves are generated to provide a minimum temperature limit to which the vessel can be pressurized.

An initial nil-ductility reference temperature (RT_{NDT}) is determined for vessel materials before exposure to neutron radiation raises this transition temperature. This increase or shift in the initial nil-ductility reference temperature (ΔRT_{NDT}) means higher temperatures are required for the material to continue to act in a ductile manner. The P-T curves are determined by the RT_{NDT} and ΔRT_{NDT} values for the licensed operating period along with appropriate margins.

The reactor vessel ΔRT_{NDT} and USE, calculated on the basis of neutron fluence, are part of the licensing basis, and support safety determinations. Therefore, these calculations are TLAAs. The increases in RT_{NDT} (ΔRT_{NDT}) affect the bases for relief from circumferential weld inspection and its associated supporting calculation of limiting axial weld conditional failure probability. As such, circumferential weld examination relief and axial weld failure probability are also TLAAs. Section 4.2 includes the following TLAA discussions related to the issue of neutron embrittlement:

- Reactor Vessel Materials Upper-Shelf Energy Reduction Due to Neutron Embrittlement
- Adjusted Reference Temperature for Reactor Vessel Materials Due to Neutron Embrittlement
- Reflood Thermal Shock Analysis of the Reactor Vessel
- Reflood Thermal Shock Analysis of the Reactor Vessel Core Shroud and Repair Hardware
- Reactor Vessel Thermal Limit Analysis: Operating Pressure–Temperature Limits
- Reactor Vessel Circumferential Weld Examination Relief
- Reactor Vessel Axial Weld Failure Probability

4.2.1 Reactor Vessel Materials Upper-Shelf Energy Reduction Due to Neutron Embrittlement

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

Upper shelf energy (USE) is the standard industry parameter used to indicate the maximum toughness of a material at high temperature. 10 CFR 50 Appendix G requires the predicted end-of-life Charpy impact test USE for reactor vessel materials to be at least 50 ft-lb (absorbed energy), unless an approved analysis supports a lower value. Initial unirradiated test data are not available for the Dresden or Quad Cities reactor vessels to demonstrate a minimum 50 ft-lb USE by standard methods. End-of-life fracture energy was evaluated by using an equivalent margin analysis (EMA) methodology approved by the NRC in NEDO-32205-A. This analysis confirmed that an adequate margin of safety against fracture, equivalent to 10 CFR 50 Appendix G requirements, does exist.

The end-of-life upper shelf energy calculations satisfy the criteria of 10 CFR 54.3(a). As such, these calculations are a TLAA.

Analysis

The Dresden and Quad Cities reactor vessels were designed for a 40-year life with an assumed neutron exposure of less than 10^{19} n/cm^2 from energies exceeding 1 MeV. The current licensing basis calculations use realistic calculated fluences that are lower than this limiting value. The design basis value of 10^{19} n/cm^2 bounds calculated fluences for the original 40-year term for all four units.

The tests performed on reactor vessel materials under the code of record provided limited Charpy impact data. It was not possible to develop original Charpy impact test USE values using the ASME III NB-2300, Summer 1972 (and later) methods invoked by 10 CFR 50 Appendix G. Therefore, alternative methods approved by the NRC in NEDO-32205-A, were used to demonstrate compliance with the 40-year 50 ft-lb USE requirement.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

Fluences were calculated for the Dresden and Quad Cities reactor vessels for the extended 60-year (54 EFPY) licensed operating periods, using the methodology of NEDC-32983P, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation," which was approved by the NRC in a letter dated September 14, 2001 from S.A. Richards (NRC) to J.F. Klapproth (GE). (Reference 4.2) One bounding fluence calculation was performed for Dresden and Quad Cities. Peak fluences were calculated at the vessel inner surface (inner diameter), for purposes of evaluating USE. The value of neutron fluence was also calculated for the 1/4T location into the vessel wall measured radially from the inside diameter (ID), using Equation 3 from Paragraph 1.1 of Regulatory Guide 1.99, Revision 2. This 1/4T depth is recommended in the ASME Boiler and Pressure Vessel Code Section XI, Appendix G, 1998 Edition, Addendum 2000, Sub-article G-2120 as the maximum postulated defect depth.

The 54 EFPY USE was evaluated by an equivalent margin analysis (EMA) using the 54 EFPY calculated fluence and Dresden and Quad Cities surveillance capsule results. EPRI TR-113596, "BWR Reactor Pressure Vessel Inspection and Flaw Evaluation Guidelines," BWRVIP-74, September 1999, performs a generic analysis and determines that the percent reduction in Charpy USE for the limiting BWR/3-6 plates and BWR/2-6 welds are 23.5 per cent and 39 per cent respectively. Summary tables 4.2.1-1 through 4.2.1-8 provide results of the equivalent margin analysis for limiting welds and plates on the reactor vessels at both plants. The results show that the limiting USE EMA percent is less than the BWRVIP-74 EMA percent acceptance criterion in all cases.

A report summarizing the results of the equivalent margin analysis will be submitted for NRC approval by December 31, 2003. This report will be the basis for demonstrating compliance to 10 CFR 50 Appendix G for the Dresden and Quad Cities reactor vessels. Exelon will manage the 54 EFPY USE values in conjunction with the surveillance capsule results from the BWRVIP Integrated Surveillance Program (BWRVIP reports 78 and 86). See the Reactor Vessel Surveillance Program (B.1.22).

Table 4.2.1-1: Equivalent Margin Analysis for Dresden Unit 2 Plate Material

BWR/3-6 PLATE
Surveillance Plate USE: %Cu = 0.19 1st Capsule Fluence = 1.3×10^{16} n/cm² 2nd Capsule Fluence = 5.2×10^{16} n/cm² 1st Capsule Measured % Decrease = 9 (Charpy Curves) 2nd Capsule Measured % Decrease = 13 (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 6 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 9 (R.G. 1.99, Figure 2)
Limiting Beltline Plate USE: %Cu = 0.23 54 EFPY 1/4T Fluence = 3.9×10^{17} n/cm² R.G. 1.99 Predicted % Decrease = 15.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = 21 (R.G. 1.99, Position 2.2)
$21 \leq 23.5\%$, so vessel plates are bounded by equivalent margin analysis

Table 4.2.1-2: Equivalent Margin Analysis for Dresden Unit 2 Weld Material

BWR/2-6 WELD
Surveillance Weld USE: %Cu = 0.17 1st Capsule Fluence = 1.3 x 10^{16} n/cm^2 2nd Capsule Fluence = 5.2 x 10^{16} n/cm^2 1st Capsule Measured % Decrease = N/A (Charpy Curves) 2nd Capsule Measured % Decrease = N/A (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 9 (R.G. 1.99, Figure 2)
Limiting Beltline Weld USE: %Cu = 0.24 54 EFPY 1/4T Fluence = 3.9 x 10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 18.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = N/A (R.G. 1.99, Position 2.2)
18.5 $\leq$ 39% , so vessel welds are bounded by equivalent margin analysis

Table 4.2.1-3: Equivalent Margin Analysis for Dresden Unit 3 Plate Material

BWR/3-6 PLATE
Surveillance Plate USE: %Cu = 0.13 1st Capsule Fluence = 9.3×10^{15} n/cm^2 2nd Capsule Fluence = 2.9×10^{16} n/cm^2 3rd Capsule Fluence = 7.1×10^{16} n/cm^2 1st Capsule Measured % Decrease = 0 (Charpy Curves) 2nd Capsule Measured % Decrease = - 4 (increase) (Charpy Curves) 3rd Capsule Measured % Decrease = - 11 (increase) (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 4 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 6 (R.G. 1.99, Figure 2) 3rd Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2)
Limiting Beltline Plate USE: %Cu = 0.23 54 EFPY 1/4T Fluence = 3.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 15.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = N/A (R.G. 1.99, Position 2.2)
15.5 $\leq$ 23.5% , so vessel plates are bounded by equivalent margin analysis

Table 4.2.1-4: Equivalent Margin Analysis for Dresden Unit 3 Weld Material

BWR/2-6 WELD
<u>Surveillance Weld USE:</u> %Cu = 0.20 1st Capsule Fluence = 9.3×10^{15} n/cm^2 2nd Capsule Fluence = 2.9×10^{16} n/cm^2 3rd Capsule Fluence = 7.1×10^{16} n/cm^2 1st Capsule Measured % Decrease = - 7 (increase) (Charpy Curves) 2nd Capsule Measured % Decrease = - 51 (increase) (Charpy Curves) 3rd Capsule Measured % Decrease = 0 (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 9 (R.G. 1.99, Figure 2) 3rd Capsule R.G. 1.99 Predicted % Decrease = 11 (R.G. 1.99, Figure 2)
<u>Limiting Beltline Weld USE:</u> %Cu ≐ 0.34 54 EFPY 1/4T Fluence = 2.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 21.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = N/A (R.G. 1.99, Position 2.2)
21.5 $\leq$ 39% , so vessel welds are bounded by equivalent margin analysis

Table 4.2.1-5: Equivalent Margin Analysis for Quad Cities Unit 1 Plate Material

BWR/3-6 PLATE
<u>Surveillance Plate USE:</u> %Cu = 0.22 1st Capsule Fluence = 1.03×10^{16} n/cm^2 2nd Capsule Fluence = 5.5×10^{16} n/cm^2 1st Capsule Measured % Decrease = 0 (Charpy Curves) 2nd Capsule Measured % Decrease = 0 (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 10 (R.G. 1.99, Figure 2)
<u>Limiting Beltline Plate USE:</u> %Cu = 0.27 54 EFPY 1/4T Fluence = 2.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 16.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = N/A (R.G. 1.99, Position 2.2)
16.5 $\leq$ 23.5% , so vessel plates are bounded by equivalent margin analysis

Table 4.2.1-6: Equivalent Margin Analysis for Quad Cities Unit 1 Weld Material

BWR/2-6 WELD
Surveillance Weld USE: %Cu = 0.17 1st Capsule Fluence = 1.03×10^{16} n/cm^2 2nd Capsule Fluence = 5.5×10^{16} n/cm^2 1st Capsule Measured % Decrease = 5 (Charpy Curves) 2nd Capsule Measured % Decrease = 12 (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 10 (R.G. 1.99, Figure 2)
Limiting Beltline Weld USE: %Cu = 0.27 54 EFPY 1/4T Fluence = 2.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 18.5 (R.G. 1.99, Figure 2) Adjusted % Decrease = 17.5 (R.G. 1.99, Position 2.2)
18.5 $\leq$ 39%, so vessel welds are bounded by equivalent margin analysis

Table 4.2.1-7: Equivalent Margin Analysis for Quad Cities Unit 2 Plate Material

BWR/3-6 PLATE
Surveillance Plate USE: %Cu = 0.09 1st Capsule Fluence = 1.69×10^{16} n/cm^2 2nd Capsule Fluence = 6.6×10^{16} n/cm^2 1st Capsule Measured % Decrease = 2 (Charpy Curves) 2nd Capsule Measured % Decrease = - 9 (increase) (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 4 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 6 (R.G. 1.99, Figure 2)
Limiting Beltline Plate USE: %Cu = 0.18 54 EFPY 1/4T Fluence = 2.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 12 (R.G. 1.99, Figure 2) Adjusted % Decrease = N/A (R.G. 1.99, Position 2.2)
$12 \leq 23.5\%$, so vessel plates are bounded by equivalent margin analysis

Table 4.2.1-8: Equivalent Margin Analysis for Quad Cities Unit 2 Weld Material

BWR/2-6 WELD
<u>Surveillance Weld USE:</u> %Cu = 0.14 1st Capsule Fluence = 1.69×10^{16} n/cm^2 2nd Capsule Fluence = 6.6×10^{16} n/cm^2 1st Capsule Measured % Decrease = 12 (Charpy Curves) 2nd Capsule Measured % Decrease = 32 (Charpy Curves) 1st Capsule R.G. 1.99 Predicted % Decrease = 7 (R.G. 1.99, Figure 2) 2nd Capsule R.G. 1.99 Predicted % Decrease = 9 (R.G. 1.99, Figure 2)
<u>Limiting Beltline Weld USE:</u> %Cu = 0.24 54 EFPY 1/4T Fluence = 3.9×10^{17} n/cm^2 R.G. 1.99 Predicted % Decrease = 18.5(R.G. 1.99, Figure 2) Adjusted % Decrease = 39 (R.G. 1.99, Position 2.2)
39 $\leq$ 39% , so vessel welds are bounded by equivalent margin analysis

4.2.2 Adjusted Reference Temperature for Reactor Vessel Materials Due to Neutron Embrittlement

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The initial RT_{NDT}, nil-ductility reference temperature, is the temperature at which a non-irradiated metal (ferritic steel) changes in fracture characteristics going from ductile to brittle behavior. RT_{NDT} was evaluated according to the procedures in the ASME Code, Paragraph NB-2331. Neutron embrittlement raises the initial nil-ductility reference temperature. 10 CFR 50 Appendix G defines the fracture toughness requirements for the life of the vessel. The shift to the initial nil-ductility reference temperature (ΔRT_{NDT}) is evaluated as the difference in the 30 ft-lb index temperatures from the average Charpy curves measured before and after irradiation. This increase (ΔRT_{NDT}) means that higher temperatures are required for the material to continue to act in a ductile manner. The adjusted reference temperature (ART) is defined as RT_{NDT} + ΔRT_{NDT} + margin. The margin is defined in Regulatory Guide 1.99, Revision 2. The P-T curves are developed from adjusted reference temperatures (ART) for the vessel materials. These are determined by the unirradiated RT_{NDT} and by the ΔRT_{NDT} calculations for the licensed operating period. Regulatory Guide 1.99 defines the calculation methods for ΔRT_{NDT}, ART, and end-of-life USE.

The ΔRT_{NDT} and ART calculations meet the criteria of 10 CFR 54.3(a). As such, they are TLAAs.

Analysis

The Dresden and Quad Cities reactor vessels were designed for a 40-year life with an assumed neutron exposure of less than 10^{19} n/cm^2 from energies exceeding 1 MeV. (References 4.3 and 4.4). The current licensing basis calculations use realistic calculated fluences that are lower than this limiting value. The design basis value of 10^{19} n/cm^2 bounds calculated fluences for the original 40-year term for all four units. The ΔRT_{NDT} values were determined using the embrittlement correlations defined in Regulatory Guide 1.99, Revision 2.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

Fluences were calculated for the Dresden and Quad Cities reactor vessels for the extended 60-year (54 EFPY) licensed operating periods, using the methodology of NEDC-32983P, "General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation," which was approved by the NRC in a letter dated September 14, 2001 from S.A. Richards (NRC) to J.F. Klapproth (GE). (Reference 4.2) One bounding calculation was performed for Dresden and Quad Cities. Peak fluences were calculated at the vessel inner surface (inner diameter) for purposes of evaluating USE and ART. The value of neutron fluence was also calculated for the 1/4T location into the vessel wall measured radially from the inside diameter (ID), using Equation 3 from Paragraph 1.1 of Regulatory Guide 1.99, Revision 2. This 1/4T depth is recommended in the ASME Boiler and Pressure Vessel Code Section XI, Appendix G Sub-article G-2120 as the maximum postulated defect depth.

The 54 EFPY ΔRT_{NDT} for all belt line materials were calculated based on the embrittlement correlation found in Regulatory Guide 1.99, Revision 2. The peak fluence, $\Delta RT_{NDT,}$ and ART values for the 60-year (54 EFPY) license operating period are presented in Tables 4.2.2-1 through 4.2.2-2. These tables show that the limiting 54 EFPY ARTs allow P-T limits that will provide reasonable operational flexibility. Exelon will manage the 54 EFPY ΔRT_{NDT} and ART values in conjunction with the surveillance capsule results from the BWRVIP Integrated Surveillance Program (BWRVIP reports 78 and 86). See the Reactor Vessel Surveillance Program (B.1.22) for additional details.

It should be noted that the ΔRT_{NDT} and ART values are provided for one limiting material. Code Case N-588 was used for development of the associated Pressure-Temperature Operating curves, which caused the axial weld to be the limiting material. Due to the refinement in the approved methodology used to calculate the 54 EFPY fluence, the material with the limiting ART is the axial weld, with the exception of Dresden Unit 3 where the axial weld and girth weld ART values are identical. Code Case N-588 is required for Dresden Unit 3 and causes the axial weld to become the limiting material; therefore, information for the single limiting material is presented in Tables 4.2.2-1 and 4.2.2-2.

Table 4.2.2-1 54 EFPY Analysis Results for Dresden Units 2 & 3

Parameter	Unit 2	Unit 3
Peak Surface Fluence (n/cm^2)	5.7×10^{17} n/cm^2	5.7×10^{17} n/cm^2
1/4T Fluence (n/cm^2)	3.9×10^{17} n/cm^2	3.9×10^{17} n/cm^2
ΔRT_{NDT} (°F)	36	36
ART (°F)	104	104

Table 4.2.2-2 54 EFPY Analysis Results for Quad Cities Units 1 & 2

Parameter	Unit 1	Unit 2
Peak Surface Fluence (n/cm^2)	5.7×10^{17} n/cm^2	5.7×10^{17} n/cm^2
1/4T Fluence (n/cm^2)	3.9×10^{17} n/cm^2	3.9×10^{17} n/cm^2
ΔRT_{NDT} (°F)	36	36
ART (°F)	104	104

4.2.3 Reflood Thermal Shock Analysis of the Reactor Vessel

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The Dresden and Quad Cities UFSARs describe an end-of-life thermal shock analysis performed on the reactor vessels for a design basis LOCA followed by a low-pressure coolant injection. The effects of embrittlement assumed by this thermal shock analysis will change with an increase in the licensed operating period. This analysis satisfies the criteria of 10 CFR 54.3(a). As such, this analysis is a TLAA.

Analysis

For the current operating period, a thermal shock analysis was originally performed on the reactor vessel components at Dresden and Quad Cities. The analysis assumed a design basis LOCA followed by a low-pressure coolant injection accounting for the full effects of neutron embrittlement at the end of life (40 years). The analysis showed that the total maximum vessel irradiation (1MeV) at the mid-core inside of the vessel to be 2.4×10^{17} n/cm^2 which was below the threshold level of any nil-ductility temperature shift for the vessel material. As a result, it was concluded that the irradiation effects on all locations of the reactor vessels could be ignored. However, this analysis only bounded 40 years of operation.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The original analysis has since been superseded by an analysis for BWR-6 vessels that is applicable to the Dresden and Quad Cities BWR-3 reactor vessels. (Reference 4.8) This revised analysis assumes end-of-life material toughness, which in turn depends on end-of-life adjusted reference temperature (ART). The critical location for fracture mechanics analysis is at ¼ of the vessel thickness (from the inside, 1/4T). For this event, the peak stress intensity occurs at approximately 300 seconds after the LOCA.

The analysis shows that at 300 seconds into the thermal shock event, the temperature of the vessel wall at 1.5 inches deep (which is 1/4T) is approximately 400°F (200°C). The 54 EFPY ART values described in Section 4.2.2 and tabulated in Tables 4.2.2-1 and 4.2.2-2 list the ARTs for the limiting material (weld metal) of the Dresden and Quad Cities reactor vessels. The worst-case calculated reactor vessel beltline material ART is 104°F which is well below the 400°F (204°C) 1/4T temperature predicted for the thermal shock event at the time of peak stress intensity. Therefore, the revised analysis is valid for the period of extended operation.

4.2.4 Reflood Thermal Shock Analysis of the Reactor Vessel Core Shroud and Repair Hardware

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

Radiation embrittlement may affect the ability of reactor vessel internals, particularly the core shroud and repair hardware, to withstand a low-pressure coolant injection (LPCI) thermal shock transient. Core shroud repair hardware was installed on the Dresden and Quad Cities core shrouds after 20 years of operation when cracks were found on the shroud. The analysis of core shroud strain due to reflood thermal shock is a TLAA because it is part of the current licensing basis, supports a safety determination, and is based on the calculated lifetime neutron fluence.

Analysis

The reactor vessel core shrouds were evaluated for a LPCI reflood thermal shock transient considering the embrittlement effects of lifetime radiation exposure (32 EFPY). The core shrouds receive the maximum irradiation on the inside surface opposite the midpoint of the fuel centerline. The total integrated neutron fluence at end of life at inside surface of the shroud is anticipated to be 2.7×10^{20} nvt (greater than 1 MeV). The maximum thermal shock stress in this region will be 155,700 psi equivalent to 0.57% strain. This strain range of 0.57% was calculated at the midpoint of the shroud, the zone of highest neutron irradiation. The calculated strain range of 0.57% represents a considerable margin of safety below measured values of percent reduction in area for annealed Type 304 stainless steel irradiated to 1×10^{21} nvt (greater than 1 MeV).

The value of percent reduction in area for Type 304 stainless steel is a minimum of approximately 38% for a temperature of 550°F with a neutron fluence of 1×10^{21} nvt (greater than 1 MeV) and a reduction in area of 52.5% for a temperature of 750°F with a neutron fluence of 6.9×10^{21} nvt (greater than 1 MeV). At lower values of temperature or neutron fluence, the percent reduction in area is generally higher. Therefore, thermal shock effects on the shroud at the point of highest irradiation level will not jeopardize the proper functioning of the shroud following the design basis accident (DBA) during the current licensed operating period (40 years).

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

As discussed above, core shroud components were evaluated for a reflood thermal shock event, considering the embrittlement effects of lifetime radiation exposure. The analysis includes the most irradiated point on the inner surface of the shroud where the calculated value of fluence for 40-year operating period as below the threshold (3.0×10^{20} n/cm^2) for material property changes due to irradiation. However, using the approved fluence methodology discussed in Section 4.2.2, the 54 EFPY fluence at the most irradiated point on the core shroud was calculated to be 5.85×10^{20} n/cm^2.

The allowable value of the thermal strain for irradiation levels in excess of 1×10^{21} n/cm^2 and for this faulted event is at least 20% (Reference 4.9). Since this value is far in excess of the calculated thermal shock strain amplitude of (0.6/2)% or 0.3%, the calculated thermal shock strain at the most irradiated location is acceptable considering the embrittlement effects for a 60-year operating period. Therefore, the peak thermal shock strain location is acceptable considering the embrittlement effects for a 60-year (54 EFPY) operating period.

The shroud repair hardware was designed with a 40-year design life. Since the hardware was installed more than 20 years into operation, the design life includes the period of extended operation and no additional evaluation is necessary.

4.2.5 Reactor Vessel Thermal Limit Analyses: Operating Pressure – Temperature Limits

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The Adjusted Reference Temperature (ART) is the value of Initial RT_{NDT} + ΔRT_{NDT} + margins for uncertainties at a specific location. Neutron embrittlement increases the ART. Thus, the minimum temperature at which a reactor vessel is allowed to be pressurized increases. The ART of the limiting beltline material is used to correct the beltline P-T limits to account for irradiation effect.

10 CFR Part 50 Appendix G requires reactor vessel thermal limit analyses to determine operating pressure-temperature (P-T) limits for boltup, hydrotest, pressure tests and normal operating and anticipated operational occurrences. Operating limits for pressure and temperature are required for three categories of operation: 1) hydrostatic pressure tests and leak tests, referred to as Curve A; 2) non-nuclear heat-up / cooldown and low-level physics tests, referred to as Curve B; and 3) core critical operation, referred to as Curve C. Pressure/temperature limits are developed for three vessel regions: the upper vessel region, the core beltline region, and the lower vessel bottom head region.

The calculations associated with generation of the P-T curves satisfy the criteria of 10 CFR 54.3(a). As such, this topic is a TLAA.

Analysis

The Dresden and Quad Cities Technical Specifications contain P-T limit curves for heat-up, cooldown, and in-service leakage and hydrostatic testing and also limit the maximum rate of change of reactor coolant temperature. The criticality curves provide limits for both heat-up and criticality calculated for a 32 EFPY operating period. Because of the relationship between the P-T limits and the fracture toughness transition of the reactor vessel, both Dresden and Quad Cities will require new P-T limits to be calculated and approved before the extended period of operation.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

Revised P-T limits will be prepared and submitted to the NRC for approval prior to the start of the extended period of operation using an approved fluence methodology for Dresden and Quad Cities. The analysis will utilize Code Case N-640 and N-588 (Dresden Unit 3 only). Exelon will manage the P-T curves using approved fluence calculations when there are changes in power of core design in conjunction with surveillance capsule results from the BWRVIP Integrated Surveillance Program (BWRVIP reports 78 and 86). See the Reactor Vessel Surveillance Program (B.1.22) for additional discussion.

4.2.6 Reactor Vessel Circumferential Weld Examination Relief

Applicability

This section applies to Dresden only.

Summary Description

Relief from reactor vessel circumferential weld examination requirements under Generic Letter 98-05 is based on probabilistic assessments that predict an acceptable probability of failure per reactor operating year. The analysis is based on reactor vessel metallurgical conditions as well as flaw indication sizes and frequencies of occurrence that are expected at the end of a licensed operating period.

Dresden has received this relief for the remaining 40 year licensed operating period. Quad Cities never submitted a relief request for the remaining 40 year licensed operating period. (Reference 4.27) As such, the supporting evaluations only apply to Dresden. The circumferential weld examination relief analysis meets the requirements of 10CFR54.3(a) and is a TLAA.

Analysis

Dresden received NRC approval for a technical alternative which eliminated the reactor vessel circumferential shell weld inspections for the current license term. The basis for this relief request was an analysis that satisfied the limiting conditional failure probability for the circumferential welds at the expiration of the current license, based on BWRVIP-05 and the extent of neutron embrittlement. The anticipated changes in metallurgical conditions expected over the extended licensed operating period require an additional analysis for 54 EFPY and approval by the NRC to extend this relief request.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

The USNRC evaluation of BWRVIP-05 utilized the FAVOR code to perform a probabilistic fracture mechanics (PFM) analysis to estimate the RPV shell weld failure probabilities. Three key assumptions of the PFM analysis are: 1) the neutron fluence that was the estimated end-of-life mean fluence, 2) the chemistry values are mean values based on vessel types, and 3) the potential for beyond-design-basis events is considered. Table 4.2.6-1 provides a comparison of the Dresden reactor vessel limiting circumferential weld parameters to those used in the NRC analysis for the first two key assumptions. Data provided in Table 4.2.6-1 was supplied from Tables 2.6-4 and 2.6-5 of the Final Safety Evaluation of the BWR Vessel and Internals Project BWRVIP-05 Report.

Although the chemistry composition and chemistry factor for unit 3 are higher than the limits of the NRC Analysis; the 54 EFPY fluence results are considerably lower for both Dresden Units 2 and 3. As a result, the shifts in reference temperature for both units are lower than the 54 EFPY shift from the NRC analysis. In addition, the unirradiated reference temperatures for both Dresden units are lower. The combination of unirradiated reference temperature ($RT_{NDT(U)}$) and shift (ΔRT_{NDT} w/o margin) yields adjusted reference temperatures that are considerably lower than the NRC mean analysis values. Therefore, the RPV shell weld embrittlement due to fluence has a negligible effect on the probabilities of RPV shell weld failure. The Mean RT_{NDT} values for both units at 54 EFPY are bounded by the 64 EFPY Mean RT_{NDT} provided the NRC. Although a conditional failure probability has not been calculated, the fact that the Dresden 54 EFPY values are less than the 64 EFPY value provided by the NRC leads to the conclusion that the Dresden RPV conditional failure probability is bounded by the NRC analysis.

The procedures and training used to limit cold over-pressure events will be the same as those approved by the NRC when Dresden requested the BWRVIP-05 technical alternative be used for the current term (Reference 4.14). An extension of this relief for Dresden for the 60-year period will be submitted to the NRC for approval prior to the period of extended operation.

Table 4.2.6-1 Effects for Irradiation on RPV Circumferential Weld Properties Dresden Units 2 & 3

Group	B&W 64 EFPY	Dresden Unit 2 54 EFPY	Dresden Unit 3 54 EFPY
Cu%	0.31	0.23	0.34
Ni%	0.59	0.59	0.68
CF	196.7	168	221
Fluence at clad/weld interface (10^{19} n/cm^2)	0.19	0.042	0.041
ΔRT_{NDT} w/o margin (°F)	109.4	36	47
$RT_{NDT(U)}$ (°F)	20	10	-5
Mean RT_{NDT} (°F)	129.4	46	42
P(FIE) NRC	4.83×10^{-4}	---	---
P(FIE) BWRVIP	---	---	---

4.2.7 Reactor Vessel Axial Weld Failure Probability

Applicability

This section applies to Dresden only.

Summary Description

The Boiling Water Reactor Owner's Group Vessel and Internals Program recommendations for inspection of reactor vessel shell welds (BWRVIP-05, Reference 4.14) contain generic analyses supporting an NRC SER (Reference 4.15) conclusion that the generic-plant axial weld failure rate is no more than 5×10^{-6} per reactor year. BWRVIP-05 showed that this axial weld failure rate of 5×10^{-6} per reactor year is orders of magnitude greater than the 40-year end-of-life circumferential weld failure probability, and used this analysis to justify relief from inspection of the circumferential welds as described in Section 4.2.6

Dresden received relief from the circumferential weld inspections for the remaining 40 year licensed operating period. Quad Cities never submitted a relief request for the remaining 40-year license operating period. As such, the supporting evaluations only apply to Dresden.

Analysis

As stated in Section 4.2.6, Dresden Station received NRC approval for a technical alternative which eliminated the reactor vessel circumferential shell weld inspections for the current license term. The basis for this relief request was an analysis that satisfied the limiting conditional failure probability for the circumferential welds at the expiration of the current license, based on BWRVIP-05 and the extent of neutron embrittlement. The NRC SER associated with BWRVIP-05 (Reference 4.15) concluded that the reactor vessel failure frequency due to failure of the limiting axial welds in the BWR fleet at the end of 40 years of operation is less than 5×10^{-6} per reactor year. This failure frequency is dependent upon given assumptions of flaw density, distribution, and location. The failure frequency also assumes that "essentially 100%" of the reactor vessel axial welds will be inspected.

Due to various obstructions within the reactor vessel, Dresden has not been able to meet the "essentially 100%" inspection requirement. As such, an analysis was performed to assess the effect on the probability of fracture due to the actual inspection performed on the vessel axial welds and to determine if the coverage was sufficient in the inspection of regions contributing to the majority of the risk. The analysis included an estimate and comparison of the probability of failure for the cases of "essentially 100%" inspection and the limited scope inspections on the Dresden Unit 2 and Unit 3 vessel axial welds. The analysis concluded that the conditional probabilities of failure due to a low temperature over pressurization event are very small, 7.4×10^{-10} and 7.88×10^{-12} on a per year basis for Dresden Unit 2 and Unit 3, respectively. The conditional probability of failure with the "essentially 100%" inspections were an order of magnitude lower than that for the actual inspection coverage. However, the analysis only applies to the current 40-year operating period. The anticipated changes in metallurgical conditions expected over the extended licensed operating period require an additional analysis for 54 EFPY and approval by the NRC to extend the reactor vessel circumferential weld inspection relief request.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

Table 4.2.7-1 compares the limiting axial weld 54 EFPY properties for Dresden Units 2 and 3 against the values taken from Table 2.6-5 found in the NRC SER for BWRVIP-05 and associated supplement to the SER (Reference 4.16). The SER supplement required the limiting axial weld to be compared with data found in Table 3 of the document. For Dresden, the comparison was made to the Clinton plant information. The supplemental SER stated that the axial welds for the Clinton plant are the limiting welds for the BWR fleet and vessel failure probability calculations determined for Clinton should bound those for the BWR fleet.

The limiting axial welds at Dresden are all electroslag welds with similar chemistry. The Dresden limiting weld chemistry, chemistry factor (CF), and 54 EFPY mean RT_{NDT} values are within the limits of the values assumed in the analysis performed by the NRC staff in the March 7, 2000 BWRVIP-05 SER supplement and the 64 EFPY limits and values obtained from Table 2.6.5 of the SER.

As stated above, the probability of a failure event P_{FE} calculated by the NRC BWRVIP-05 SER and its supplements depends in part on an assumption that 90 per cent of axial welds can be inspected. Less than 90 per cent of axial welds can be examined at Dresden. As such, an analysis was performed for 54 EFPY to assess the effect on the probability of fracture due to the actual inspection performed on the vessel axial welds and to determine if the coverage was sufficient in the inspection of regions contributing to the majority of the risk. The analysis included the estimate and comparison of the probability of failure for the cases of "essentially 100%" inspection and the limited scope inspections on the Dresden Unit 2 and Unit 3 vessel axial welds. The analysis concluded that the conditional probabilities of failure due to a low temperature over pressurization event are very small, 3.89×10^{-8} and 5.07×10^{-8} on a per year basis for Dresden Unit 2 and Unit 3, respectively. The evaluation shows that the calculated unit-specific axial weld conditional failure probabilities at 54 EFPY for Dresden are less than the failure probabilities calculated by the NRC staff in the SER at 64 EFPY and the limiting Clinton values found in Table 3 of the SER supplement. The probability of failure of an axial weld at Dresden will therefore provide adequate margin above the probability of failure of a circumferential weld, in support of relief from inspection of circumferential welds, for the extended licensed operating period.

Table 4.2.7-1 Effects for Irradiation on RPV Axial Weld Properties
Dresden Units 2 & 3

Value	B&W 64 EFPY	SER Supplement (Clinton)	DRE 2 54 EFPY	DRE 3 54 EFPY
Cu%	0.25	0.10	0.24	0.24
Ni%	0.35	1.08	0.37	0.37
CF	142.5	—	141	141
Fluence x 10^{19} n/cm^2	0.35	0.69	0.057	0.057
ΔRT_{NDT} °F	88.9	121	36	36
$RT_{NDT(U)}$ °F	10	-30	23	23
Mean RT_{NDT} °F	98.9	91	59	59
P(FIE) NRC	1.87×10^{-1}	2.73×10^{-3}	3.89×10^{-8}	5.07×10^{-8}
$P_{(FIE)}$ BWRVIP	—	1.52×10^{-3}	—	—

4.3 METAL FATIGUE OF THE REACTOR VESSEL, INTERNALS, AND REACTOR COOLANT PRESSURE BOUNDARY PIPING AND COMPONENTS

A cyclically loaded metal component may fail because of fatigue even though the cyclic stresses are considerably less than the static design limit. Some design codes therefore contain explicit metal fatigue calculations or design limits, such as the ASME Boiler and Pressure Vessel Code and the ANSI piping codes. Cyclic or fatigue design of other components may not be to these codes, but may use similar methods. These analyses, calculations and designs to cycle count limits or to fatigue usage factor limits may be TLAAs.

Fatigue analyses are presented in the following groupings:

- Reactor Vessel Fatigue Analyses
- Reactor Vessel Internals Fatigue Analysis
  - o Low Cycle Fatigue of Core Shroud and Repair Hardware
  - o High Cycle Fatigue of Jet Pump Riser Braces
- Reactor Coolant Pressure Boundary Piping and Component Fatigue Analysis
  - o Piping and Components Designed in Accordance With ASME Section III Class 1
  - o Piping and Components Designed in Accordance with USAS B31.1, ASME Section III Class 2 and 3, or ASME Section III Class B and C
  - o Isolation Condenser Fatigue Analysis
- Effects of Reactor Coolant Environment on Fatigue Life of Components and Piping (Generic Safety Issue 190)

NUREG-1801 identifies numerous fatigue related aging effects that require evaluation as possible TLAAs in accordance with 10 CFR 54.21(c). Each of these is summarized in NUREG-1800 and presented in Section 3 of this LRA and referenced to the appropriate TLAA section.

4.3.1 Reactor Vessel Fatigue Analyses

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

Reactor vessel fatigue analyses of the vessel support skirt, shell, upper and lower heads, closure flanges, nozzles and penetrations, nozzle safe ends, and closure studs depend on assumed numbers and severity of normal and upset-event pressure and thermal operating cycles to predict end-of-life fatigue usage factors.

These assumed cycle counts and fatigue usage factors are based on 40 years of operation. Calculation of fatigue usage factors is part of the current licensing basis and is used to support safety determinations. The reactor vessel fatigue analyses are TLAAs.

Analysis

The original reactor pressure vessel stress report included a fatigue analysis for the reactor vessel components based on a set of design basis duty cycles. These duty cycles are listed in Table 3.9-1 of the Dresden and Quad Cities UFSARs. The original 40-year analyses demonstrated that the cumulative usage factors (CUF) for the critical components would remain below the ASME Code Section III allowable value of 1.0.

A reanalysis was performed for reactor vessel cumulative fatigue usage factors as a part of Extended Power Uprate (EPU) implementation at all four Dresden and Quad Cities units. (References 4.10 and 4.11) A subset of the bounding reactor vessel components was evaluated as a part of this re-analysis. The resulting fatigue cumulative usage factors (CUFs) for these limiting components supersede the values determined in the original reactor vessel analyses. The current bounding-case analysis (worst CUFs for all four reactor vessels) lists the following values for the 40-year CUFs for limiting components.

Shroud Support	0.820
Support Skirt	0.862
Feedwater Nozzle (Safe End)	0.748
Closure Studs	0.750

The original code analysis of the reactor vessel included fatigue analysis of the feedwater and control rod drive hydraulic system return line nozzles. After several years of operation, it was discovered that both the control rod drive hydraulic system return line nozzles and the feedwater nozzles were subject to cracking caused by a number of factors including rapid thermal cycling. Consequently, the control rod drive hydraulic system return line nozzles were capped and removed from service. As such, they are no longer subject to rapid thermal aging. A reanalysis was later performed on the feedwater nozzles along with modifications to reduce or eliminate the causes. This revised analysis included the appropriate effects from rapid thermal cycling that were attributed to the original cause of cracking in the feedwater nozzles. Both Dresden and Quad Cities also follow the improved BWR Owners Group inspection and management methods.

Disposition: Aging Management, 10 CFR 54.21(c)(1)(iii)

The fatigue cumulative usage factors (CUFs) of the reactor vessel, including the support skirt, shell, upper and lower heads, closure assembly, nozzles and penetrations, and nozzle safe ends will be managed by the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. This program will monitor CUFs through either stress-based fatigue (SBF) monitoring or cycle-based fatigue monitoring (CBF).

Stressed-based fatigue monitoring consists of computing a "real time" stress history for a given component from actual temperature, pressure, and flow histories via a finite element based Green's Function approach. CUF is then computed from the computed stress history using appropriate cycle counting techniques and appropriate ASME Code, Section III fatigue analysis methodology. SBF monitoring is intended to duplicate the methodology used in the governing ASME Code Section III stress report for the component in question, but uses actual transient severity in place of design basis transient severity.

Cycle-based fatigue monitoring consists of a two step process: (a) automated cycle counting, and (b) CUF computation based on the counted cycles. The automated cycle counting counts each transient that is defined in the plant licensing basis based upon the mechanistic process or sequence of events experienced by the plant (as determined from monitored plant instruments). The approach is conservative because it assumes each actual transient has a severity equal to that assumed in the design basis. The unique severity of any transient identified by the aging management program software is captured for each monitored component, for ready comparison to design basis transient severity. Transients defined in the Dresden and Quad Cities UFSAR are identified and implemented into the aging management program software. CUF computation calculates fatigue directly from counted transients and parameters for the monitored components. CUF is computed via a design-basis fatigue calculation where the numbers of cycles are substituted for assumed design basis number of cycles. The CUF calculations are conservative in that design basis transient severity is assumed.

All governing reactor vessel and Class 1 fatigue analyses have been reviewed to establish a comprehensive and bounding set of reactor vessel locations for inclusion in the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. All locations with 40-year CUFs expected to exceed 0.4 will be included in the program. Those locations are listed in Table 4.3.1-1 below. The associated CUFs are all based upon the original 40 year analysis. In the most limiting cases (CUF > .40), the 40-year post EPU analysis is listed.

All necessary plant transient events will be tracked to ensure that the CUF remains less than 1.0 for all monitored components. In the event fatigue cumulative usage factor is predicted to exceed 1.0 for any component prior to 60 years of operation, appropriate corrective action will be taken in accordance with the Exelon Corrective Action Program (B.2.1). The required implementing actions will be completed prior to the period of extended operation. Dresden and Quad Cities have programs in place to track operating thermal and pressure cycles and to assess their effect on vessel fatigue. The requirements from these procedures will be incorporated into the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program.

Table 4.3.1-1 Fatigue Monitoring Locations for Reactor Pressure Vessel Components

Component	Computed Fatigue Usage Factor (Pre-EPU)	Computed Fatigue Usage Factor (Post EPU)	Monitoring Technique
Recirculation Outlet Nozzle	0.270	Note 4	CBF (NUREG/CR-6260 component)
Recirculation Inlet Nozzle	0.301	Note 4	CBF (NUREG/CR-6260 component)
Feedwater Nozzle	0.538	.748	SBF (NUREG/CR-6260 component)
Core Spray Nozzle	0.079	Note 4	CBF (NUREG/CR-6260 component)
Support Skirt	0.940	0.862	SBF
Shroud Support	0.630	0.820	CBF
Closure Stud Bolts	0.79	0.75	CBF
Vessel Shell	0.141	Note 4	CBF (NUREG/CR-6260 component)

Notes:

1. CBF = Cycle-Based Fatigue and SBF = Stress-Based Fatigue
2. EPU = Extended Power Uprate
3. The components listed as a "NUREG/CR-6260 component" will be monitored for GSI –190. See Section 4.3.4
4. Only locations with 40-year CUF expected to exceed 0.400 were computed for the EPU Project.

4.3.2 Fatigue Analysis of Reactor Vessel Internals

A review of the current licensing basis found no fatigue analysis on the reactor vessel internals with the following exceptions listed below.

This section describes TLAAs arising within:

- Low-Cycle Thermal Fatigue Analysis of the Core Shroud and Repair Hardware
- High-Cycle Flow-Induced Vibration Fatigue Analysis of Jet Pump Riser Braces

4.3.2.1 Low-Cycle Thermal Fatigue Analysis of the Core Shroud and Repair Hardware

Applicability

This section applies to Quad Cities only.

Summary Description

Only one analysis of low-cycle fatigue of reactor vessel internals was identified which includes an evaluation of the core shroud and core shroud repair hardware at Quad Cities. The core shroud repair SER for Quad Cities states that the limiting upset loading condition is the cold feedwater transient and that this event is the only case that produces any fatigue in need of consideration. As such, the analysis is a TLAA.

Analysis

A review of licensing basis documents found no evidence of analyses of pressure or thermal cycle fatigue for the core plate, top guide, jet pump assemblies (other than high-cycle fatigue in the riser braces – see Section 4.3.2.2), fuel supports, in-core instrumentation tubes, or control rod drive assemblies. Low-cycle mechanical fatigue was mentioned only for the tie rod stabilizers in the core shroud repair evaluations.

The USNRC Safety Evaluation of the core shroud repair for Quad Cities (Reference 4.1) states:

> "The limiting upset loading condition event that ComEd evaluated is the cold feedwater transient that is classified as an upset loading condition. During this transient, due to the injection of cold feedwater into the shroud annulus, a maximum difference of 133° F between the hot core shroud and the cooler tie rod stabilizer assembly components could exist. This would cause an increase in the tensile load on the stabilizers and an increase in the compressive load on the core shroud. This condition was evaluated and it was determined that the stresses in the stabilizer and in the core shroud for this condition would be both less than the ASME Code upset allowable stress and less than the material yield stress, thus preventing permanent deformation, which is acceptable. ComEd also determined that this event is the only case that produces any fatigue requiring consideration. For this event, the maximum calculated fatigue usage was found to be insignificant compared to the allowable usage and is, therefore, acceptable."

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The current predicted cumulative usage factors for the Quad Cities core shrouds and core shroud repair hardware were found to be not significant, less than 0.11. A 20-year increase in service life will not raise the usage factors significantly. Therefore, the design of core shroud repair hardware for fatigue effects is valid for the extended licensed operating period.

4.3.2.2 High-Cycle Flow-Induced Vibration Fatigue Analysis of Jet Pump Riser Braces

Applicability

This section applies to Dresden Unit 2 only.

Summary Description

Flow rate through the reactor vessel leads to vibration of internal components. Certain conditions, such as increased core flow or single recirculation loop operation, can significantly increase vibration levels. To address this concern, the Dresden reactor vessel internals were instrumented and tested for vibration levels during initial plant startup. Criteria were established such that vibration levels were assured to remain below material endurance limits over the life of the plant. Various operating conditions were evaluated, including those associated with increased core flow and transient unbalanced flow conditions. Of the conditions tested, evaluation of transient unbalanced flow conditions was found to be limiting at Dresden Unit 2 for the jet pump riser braces. Although reactor internals are not code pressure boundary components, the evaluation of the Dresden Unit 2 jet pump riser braces used methods and fatigue curves similar to those of ASME Section III Class 1 fatigue analyses.

Analysis

Acceptable vibration levels for the Dresden reactor internals were based initially on the amplitude that could be permitted on a continuous basis for a 40-year plant life. Despite the fact that a 40-year basis was described in the underlying evaluations, this criterion is not time-dependent.

The original design addressed high-cycle fatigue effects in the internals and determined that these effects are acceptable over the life of the plant. The UFSAR description of the original design mentions the "reactor core support structure" and excitation by the recirculation and jet pumps, and that the jet pump lines were not a significant safety question. However, except for fatigue in the Dresden Unit 2 jet pump riser braces, the original evaluation of specific components such as the core plate, top guide, jet pump assemblies, fuel supports, or control rod drive assemblies used displacement criteria determined by a fatigue endurance that is not time-limited.

Extended power uprate (EPU) analysis found that the Dresden and Quad Cities reactor internal components with the exception of the Dresden Unit 2 jet pump riser braces, can operate at EPU conditions for a 60-year plant life without (1) exceeding the original design vibration criteria or fatigue usage during balance flow operation; or (2) developing resonance problems due to recirculation pump vane passing frequency (VPF) at EPU conditions.

The EPU project evaluated possible effects of power uprate, including increased core flow, increased pump vane-passing frequency (VPF), and other factors, and found that, with some possible exceptions (including the Dresden Unit 2 riser braces), the stress ranges of internals would remain within the original 10,000 psi endurance limit. Among the exceptions, only the evaluation of the Dresden Unit 2 jet pump riser braces included fatigue.

The final EPU report on flow induced vibration of reactor internals found that the Dresden Unit 2 jet pump riser braces might be damaged by recirculation pump vane passing frequency (VPF) vibration if operation is permitted in the maximum extended load line limit analysis (MELLA) region. Dresden Unit 2 has only one brace per riser with leaves that are thinner than the other three units. The EPU report therefore stated that significant operation of Dresden Unit 2 in a region at which the VPF is resonant with the brace leaves might produce fatigue cracks and failures in the riser braces. This might be a problem for continuous operation in the MELLA region. The Quad Cities riser brace design is identical to the Dresden Unit 3 brace design which shows no resonance effects and presents no concern.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

The Dresden Unit 2 riser braces will be repaired or replaced prior to the period of extended operation and will be qualified for the extended licensed operating period.

4.3.3 Reactor Coolant Pressure Boundary Piping and Component Fatigue Analysis

This section describes fatigue-related TLAAs arising within design analyses of:

- ASME Section III Class 1 Reactor Coolant Boundary Piping and Component Fatigue Analysis
- Reactor Coolant Pressure Boundary Piping and Components Designed to USAS B31.1, ASME Section III Class 2 and 3, or ASME Section VIII Class B and C
- Fatigue Analysis of the Isolation Condenser

4.3.3.1 ASME Section III Class 1 Reactor Coolant Pressure Boundary Piping and Component Fatigue Analysis

Applicability

This section applies to Dresden.

Summary Description

The Dresden Unit 3 recirculation piping was replaced under the IGSCC mitigation program. The pipe replacement included reactor pressure coolant boundary piping in the shutdown cooling system, low pressure coolant injection system, isolation condenser system, and reactor water cleanup system. As a part of this replacement, fatigue evaluation of the replaced portions of piping was performed. The analyses demonstrate that the 40-year cumulative usage factors (CUF) for the critical components of the replaced piping are below the ASME Code Section III allowable value of 1.0. The current analyses of record are TLAAs.

Analysis

Other than special cases under the Mark I containment "New Loads" program (see Section 4.6), the only reactor coolant pressure boundary piping that has been analyzed for fatigue at either Dresden or Quad Cities is the Dresden Unit 3 recirculation system piping. This included portions of the connected shutdown cooling, low pressure coolant injection, isolation condenser, and reactor water cleanup piping that form the reactor coolant pressure boundary.

The validation of all remaining Dresden and Quad Cities USAS B31.1 piping design is discussed in Section 4.3.3.2. All "Class I" piping at Dresden and Quad Cities was originally designed to USAS B31.1, 1967 Edition. The Dresden Unit 3 recirculation and other connected piping were replaced under the GL 88-01 IGSCC correction program. The replacement piping was analyzed to ASME Section III Class 1 rules. For an acceptable fatigue design, the ASME Code limits the CUF to less than 1.0. The ASME Section III Class 1 code analyses for the Dresden Unit 3 recirculation line and attached large bore piping replacement inside the drywell show calculated cumulative usage factors (CUFs) that exceed 0.400. These are shown in Table 4.3.3.1-1 below.

Disposition: Aging Management, 10CFR54.21(c)(1)(iii)

The Dresden Unit 3 reactor coolant pressure boundary piping will be managed by the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. This program will monitor CUFs through cycle-based fatigue monitoring (CBF).

Cycle-based fatigue monitoring consists of a two step process: (a) automated cycle counting, and (b) CUF computation based on the counted cycles. The automated cycle counting counts each transient that is defined in the plant licensing basis based upon the mechanistic process or sequence of events experienced by the plant (as determined from monitored plant instruments). The approach is conservative because it assumes each actual transient has a severity equal to that assumed in the design basis. The unique severity of any transient identified by the aging management program software is captured for each monitored component, for ready comparison to design basis transient severity. Transients defined in the Dresden and Quad Cities UFSAR are identified and implemented into the aging management program software. CUF computation calculates fatigue directly from counted transients and parameters for the monitored components. CUF is computed via a design-basis fatigue calculation where the numbers of cycles are substituted for assumed design basis number of cycles. The CUF calculations are conservative in that design basis transient severity is assumed.

All governing Dresden Unit 3 reactor coolant pressure boundary piping fatigue analyses have been reviewed to establish a comprehensive and bounding set of primary coolant boundary piping locations for inclusion in the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. All locations with 40-year CUFs expected to exceed 0.4 will be included in the program. Those locations are listed in Table 4.3.3.1-1 below. The associated CUFs are all based upon the original 40-year analysis.

All applicable plant transient events will be tracked to ensure that the CUF remains less than 1.0 for all monitored components. In the event fatigue cumulative usage is predicted to exceed 1.0 for any component prior to 60 years of operation, appropriate corrective action will be taken in accordance with the Exelon Corrective Action Program (B.2.1). The required implementing actions will be completed prior to the period of extended operation. The requirements from these procedures will be incorporated into the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program.

Table 4.3.3.1-1 Fatigue Monitoring Locations for Dresden Unit 3 Reactor Recirculation Piping

Component	Calculated Fatigue Usage Factor	Fatigue Monitoring Technique
Recirculation Suction Line	0.475	CBF
Recirculation Discharge Line (Loop B)	0.411	CBF
Shutdown Cooling Line	0.499	CBF
Loop A; Shutdown Cooling (SDC)-Isolation Condenser (ISCO) Tee	0.696	CBF
Shutdown Cooling Guard Pipe Lug	0.711	CBF
Shutdown Cooling Penetration Flued Head	0.600	CBF
2" Reactor Water Cleanup Bypass Line	0.473	CBF

4.3.3.2 Reactor Coolant Pressure Boundary Piping and Components Designed to USAS B31.1, ASME Section III Class 2 and 3, or ASME Section VIII Class B and C

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The reactor coolant pressure boundary (RCPB) piping for all of the Quad Cities and Dresden units was designed to USAS B31.1 except for some piping in Dresden Unit 3 as discussed in Section 4.3.3.1. The RCPB and non-RCPB piping in the scope of license renewal that is designed to USAS B31.1 or ASME Section III Class 2 and 3 requires the application of a stress range reduction factor to the allowable stress range for secondary (expansion and displacement) stresses to account for thermal cyclic conditions.

The codes and standards to which the Dresden and Quad Cities units were designed and constructed did not invoke fatigue analyses for piping or component supports, nor for their welds, bolted connections, or anchors. The only exceptions are some ASME Class MC containment piping support and penetration analyses for "new loads," discussed in Section 4.6, and the replaced RCPB piping in Dresden Unit 3, discussed in Section 4.3.3.1.

Analysis

USAS B31.1 (1967) is the original design code for RCPB and non-RCPB piping at the Quad Cities and Dresden units. At Dresden, piping from the reactor vessel to the first isolation or stop valve were analyzed based on ASME Section I (1965, Winter 1966 Addenda), and Nuclear Code Cases N-1 through N-11, (Reference 4.3 and 4.4). None of these codes, addenda, or cases invoke fatigue analyses. However, ASME Section III Class 2 and 3, and USAS B31.1 piping require the application of a stress range reduction factor to the allowable stress range for expansion stresses to account for cyclic thermal conditions. The allowable secondary stress range is 1.0 S_A for 7,000 equivalent full-temperature thermal cycles or less and is reduced in steps to 0.5 S_A for greater than 100,000 cycles.

With the exception of containment vent and process bellows, no components in the scope of license renewal designed to ASME Section III or Section VIII require design for cyclic thermal loading. Therefore, cycle counting is not a consideration for the following components.

Recirculation Pumps: The reactor recirculation pumps are designed per ASME Section III, Class C (1965) (Reference 4.3 and 4.4). Evaluation for thermal cycles is not required and none were performed (Reference 4.3 and 4.4).

Quad Cities RHR System: The RHR heat exchangers at Quad Cities were designed to ASME Section III (1966), Class C requirements on the shell side and Section VIII on the tube side, neither of which require design for cyclic thermal loading. The review found no other RHR components with indications of design for fatigue. The RHR system design therefore includes no TLAAs other than the piping design for USAS B31.1 stress range reduction factors.

Other than Dresden Unit 3 piping described in 4.3.3.1 above, all of the Dresden and Quad Cities RCPB and connected piping, including the portions of the main steam and SRV discharge lines inside the drywell, were designed using USAS B31.1 Power Piping Code stress range reduction factors for a finite number of thermal cycles, but have no fatigue analyses. USAS B31.1 does not require explicit fatigue analysis. Therefore CUF values were not originally calculated for the remainder of the Dresden and Quad Cities "Class I" piping.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The assumed thermal cycle count for the analyses used in the codes associated with piping and components can conservatively be approximated by the thermal cycles used in the reactor vessel fatigue analysis. These thermal cycles are listed in UFSAR Table 3.9-1. The total count of all these listed thermal cycles is less than 2200 for a 40-year plant. For the 60-year extended operating period the number of thermal cycles for piping analyses would be proportionally increased to less than 3300, a fraction of the 7000-cycle threshold. The existing piping analyses within the scope of license renewal containing assumed thermal cycle counts are valid for the period of extended operation.

4.3.3.3 Fatigue Analysis of the Isolation Condenser

Applicability

This section applies to Dresden only.

Summary Description

The Dresden isolation condensers provide core cooling when the reactor vessel becomes isolated from the turbine and the main condenser. Fatigue evaluation of the isolation condensers was performed as a part of original component design. The analyses demonstrate that the 40-year cumulative usage factors (CUF) for the critical components of the isolation condenser are below the ASME Code Section III allowable value of 1.0. The fatigue analysis of the Dresden isolation condensers is a TLAA because it is part of the current licensing basis, is used to support a safety determination, and is based on the cycles predicted for a 40-year plant life.

Analysis

The isolation condenser and the supporting system piping and components were specified for 250 shutdown depressurization cycles, with 40 to 240 depressurizations expected in 40 years, and for 250 thermal shock events in 40 years. The design analysis for thermal shock assumed 280 events, a margin of 30 cycles or 12%. The limiting thermal shock event is caused by an isolation event that raises the fluid on the secondary side of the isolation condenser to boiling at atmospheric pressure, or 212°F, followed by injection of makeup water as cold as 70°F into the secondary side. The code analysis shows that each isolation condenser operating cycle includes a thermal shock event.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The thermal shock is the most limiting of the design transients for the isolation condenser which is bounded by 280 isolation condenser operations. Since the isolation condenser is infrequently operated, records of the number of actual isolation condenser operations were not kept during the first 20 years of operation. Record keeping of isolation condenser operations began in 1996. Since that time, there have been 3 isolation condenser operations on Unit 2 and 4 operations on Unit 3. This would indicate an operating rate of 0.58 isolation condenser operations per year (4 operations ÷ 7 years).

There have been a total of 164 reactor scrams on Unit 2 from initial operation (1970) to August 2002. Unit 2 has the bounding number of scrams between the two units. Conservatively assuming that there was an isolation condenser operation every time that a unit scrammed from 1970 to 2002 and assuming an actual operating rate of 0.58 operations per year through the extended period of operation (60 years), the total number of expected isolation condenser operations would be 181 [164 + (0.58 x 28)]. This projected cycle count falls below the 280 isolation condenser operating design limit. Therefore, the design analysis remains valid for the extended period of operation.

4.3.4 Effects of Reactor Coolant Environment on Fatigue Life of Components and Piping (Generic Safety Issue 190)

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

ASME Section III uses stress versus allowable cycle curves (S-N curves) based on tests in air to determine a fatigue usage factor. Generic Safety Issue (GSI) 190 addresses the effects of reactor coolant environment on fatigue life of components and piping. The environment of a stressed component can affect fatigue life. Although GSI 190 is resolved, NUREG-1800 states "The applicant's consideration of the effects of coolant environment on component fatigue life for license renewal is an area of review" (Section 4.3.1.2). The GSI-190 review requirements are therefore imposed by NUREG-1800 and do not depend on the individual plant licensing basis.

Analysis

The NRC staff assessed the impact of reactor water environment on fatigue life at high fatigue usage locations and presented the results in NUREG/CR-6260, "Application of NUREG/CR-5999, 'Interim Fatigue Curves to Selected Nuclear Power Plant Components'," March 1995. Formulas currently acceptable to the staff for calculating the environmental correction factors for carbon and low-alloy steels are contained in NUREG/CR-6583, "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels," and those for austenitic stainless steels are contained in NUREG/CR-5704, "Effects of LWR Coolant Environments on Fatigue Design of Austenic Stainless Steels."

In order to comply with the requirements of NUREG/CR-5999, Exelon would be required to perform plant specific calculations at Dresden and Quad Cities for the locations identified in NUREG/CR-6260 for the older vintage BWR plants. For each of these locations, detailed environmental fatigue calculations would have to be performed using the appropriate F_{en} relationship from NUREG/CR-6583 (for carbon/low alloy steels) and NUREG/CR-5704 (for stainless steels), as appropriate for the material for each location. The detailed calculations must include the calculation of an appropriate F_{en} factor for each individual load pair in the governing fatigue calculation so that an overall multiplier on CUF for environmental effects can be determined for each location.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

Exelon will perform plant-specific calculations for Dresden and Quad Cities for the locations identified in NUREG/CR 6260 for older-vintage BWR. These locations are:

- Reactor Vessel (Lower Head to Shell Transition)
- Feedwater Nozzle
- Recirculation System (RHR Return Line Tee)
- Core Spray System (Nozzle and Safe End)

- Residual Heat Removal Line (Tapered Transition)
- Limiting Class 1 Location in a Feedwater Line

The list above does not specifically include the feedwater line (RCIC tee) location identified in NUREG/CR-6260 for the older-vintage GE plant. Dresden does not have a RCIC system. Quad Cities does have a RCIC system; however, the RCIC tee location is located outside the containment in the Class 2 portion of the feedwater line. Therefore, for both plants, the limiting Class 1 feedwater piping location will be evaluated for environmental fatigue effects.

For each location, detailed environmental fatigue calculations will be performed using the appropriate F_{en} relationships from NUREG/CR 6583 for carbon and low-alloy steels and from NUREG/CR 5704 for stainless steels, as appropriate for the material. The calculations will determine an appropriate F_{en} for each individual load pair in the governing fatigue calculation, so that an overall multiplier on cumulative usage factor (CUF) for environmental effects can be determined for each location. These calculations will be completed prior to the period of extended operation, and appropriate corrective action will be taken if the resulting projected end-of life CUF values exceed 1.0.

Exelon reserves the right to modify this position in the future based on the results of industry activities currently underway, or based on other results of improvements in methodology, subject to NRC approval prior to changes in this position.

4.4 ENVIRONMENTAL QUALIFICATION OF ELECTRICAL EQUIPMENT (EQ)

10 CFR 50.49, Environmental Qualification of Electrical Equipment Important to Safety for Nuclear Power Plants (Reference 4.22), requires that certain electrical and instrument and control (I&C) equipment located in harsh environments be qualified to perform their safety related functions in those harsh environments after the effects of in-service aging.

NUREG-1801 identifies numerous environmentally related aging effects that require evaluation as possible TLAAs in accordance with 10 CFR 54.21(c). Each of these is summarized in NUREG-1800 and presented in Section 3 of this LRA and referenced to the appropriate TLAA section.

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

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 component replacement or maintenance prior to the end of designated life, unless additional life is established through ongoing qualification. 10 CFR 50.49(k) and (l) permit different qualification criteria to apply based on plant vintage. Supplemental EQ regulatory guidance for compliance with these different qualification criteria is provided in the Regulatory Guide 1.89, Revision 1, "Environmental Qualification of Certain Electrical Equipment Important to Safety for Nuclear Power Plants," (Reference 4.25), the Division of Operating Reactors (DOR) Guidelines (Reference. 4.23) and NUREG-0588 (Reference. 4.24).

All operating plants must meet the requirements of 10 CFR 50.49 for certain electrical and I&C components important to safety. 10 CFR 50.49 defines the scope of components to be included, requires the preparation and maintenance of a qualification binder that includes component performance specifications, electrical characteristics, and environmental conditions. 10 CFR 50.49(f) establishes four methods of demonstrating qualification for aging and accident conditions. Compliance with 10 CFR 50.49 provides evidence that the component will perform its intended functions during and after a design basis accident after experiencing the effects of in-service aging.

The Dresden and Quad Cities EQ programs were established to demonstrate that certain electrical components located in harsh plant environment (that is, those areas of the plant that could be subject to the harsh environmental effects of loss of coolant accident [LOCA], high energy line breaks [HELB] or post-LOCA radiation) are qualified to perform their safety function operation in those harsh environments after the effects of in service aging. The Dresden and Quad Cities station EQ program complies with the requirements of 10 CFR 50.49, or DOR Guidelines for that equipment presently qualified to DOR guidelines. For Dresden and Quad Cities, the EQ-related equipment is identified in controlled equipment data bases and equipment qualification binders.

Dresden and Quad Cities EQ program manages component thermal, radiation and cyclic aging as applicable, through the aging evaluations based on 10 CFR 50.49, and DOR guidelines for those components presently qualified to DOR guidelines.

GSI 168, Environmental Qualification of Electrical Components

NRC guidance for addressing GSI-168 for license renewal is contained in the June 2, 1998, NRC letter to NEI. (Reference 4.26) In this letter, the NRC states, "With respect to addressing GSI-168 for license renewal, until completion of an ongoing research program and staff evaluations, the potential issues associated with GSI-168 and their scope have not been defined to the point that a license renewal applicant can reasonably be expected to address them at this time. Therefore, an acceptable approach described in the Statements of Consideration is to provide technical rationale demonstrating that the current licensing basis for environmental qualification pursuant to 10 CFR 50.49 will be maintained in the period of extended operation. Although the Statements of Consideration also indicates that an applicant should provide a brief description of one or more reasonable options that would be available to adequately manage the effects of aging, the staff does not expect an applicant to provide the options at this time." Consistent with the above NRC guidance, no additional information is required to address GSI-168 in a renewal application at this time.

Analysis

Aging evaluations of electrical components in the Dresden and Quad Cities EQ program that specify qualification of at least 40 years are TLAAs. As such, a reanalysis as described below will be applied to EQ components now qualified for the current operating term of 40 years.

The reanalysis of an aging evaluation may be performed to extend the qualification by reducing margin or excess conservatism incorporated in the prior evaluation. Reanalysis of an aging evaluation to extend the qualification of a component may be performed as part of the 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, unrealistically low activation energy, or in the application of a component (de-energized versus energized). The important attributes of reanalysis will include analytical methods, data collection and conservative reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met), as 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 to be 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). When used, 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 case-specific basis. Similar methods of reducing excess conservatism in the component service conditions used in prior aging evaluations may 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 maintained, replaced, or re-qualified 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 maintain, replace, or re-qualify the component if the reanalysis is unsuccessful).

Disposition: Aging Management, 10 CFR 54.21(c)(1)(iii)

The existing EQ programs will be continued for the extended operating period. Continuing the existing EQ programs provides reasonable assurance that the aging effects will be managed and that the EQ components will continue to perform their intended functions for the period of extended operation. See Environmental Qualification (EQ) of Electrical Components (B.1.35) for additional information .

4.5 LOSS OF PRESTRESS IN CONCRETE CONTAINMENT TENDONS

None of the Dresden or Quad Cities containments have prestress tendons. As such, this topic is not a TLAA.

4.6 FATIGUE OF PRIMARY CONTAINMENT, ATTACHED PIPING, AND COMPONENTS

The primary containments for Quad Cities and Dresden were designed in accordance with the ASME Code, Section III, 1965 Edition with addenda up to and including Winter 1965. Subsequently, while performing large-scale testing for the Mark III containment system and in-plant testing for Mark I primary containment systems, new suppression chamber hydrodynamic loads were identified. The "new loads" are related to the postulated loss of coolant accident (LOCA) and safety relief valve (SRV) operation. Subsequent to the original design, elements of the Dresden and Quad Cities containments were reanalyzed in response to discoveries by General Electric and others of unevaluated loads due to design basis events and SRV discharge. The load definitions include assumed pressure and temperature cycles resulting from SRV discharge and design basis loss of coolant accident (LOCA) events. This re-evaluation was in two parts: generic analyses applicable to each of the several classes of BWR containments, and Mark I Containment Program plant-unique analyses (PUA). The scope of the analyses included the pressure suppression chambers (shells and welds), the drywell-to-pressure suppression chamber vents (header and downcomers), SRV discharge piping, other piping attached to the pressure suppression chamber, penetrations, and vent bellows.

In the absence of hydrodynamic loads, fatigue is not a concern in containment design except at penetrations or other stress concentration areas. Drywell shell plates were not evaluated for fatigue in the original design and the PUA did not reevaluate the drywell, drywell penetrations, or process penetration bellows, all of which are attached to the drywell. The licensing and design basis documents do not reflect the existence of any fatigue analysis for the drywell or its penetrations. However, the drywell process bellows were specified for a finite number of operating cycles, as were replacement bellows for Quad Cities.

Containment Fatigue analyses are presented for the following groups:

- Fatigue Analysis of the Suppression Chamber, Vents, and Downcomers
- Fatigue Analysis of SRV Discharge Piping Inside the Suppression Chamber, External Suppression Chamber Attached Piping, and Associated Penetrations
- Drywell-to-Suppression Chamber Vent Line Bellows Fatigue Analyses
- Primary Containment Process Penetration Bellows Fatigue Analysis

NUREG-1801 identifies numerous fatigue related aging effects that require evaluation as possible TLAAs in accordance with 10 CFR 54.21(c). Each of these is summarized in NUREG-1800 and presented in Section 3 of this LRA and referenced to the appropriate TLAA section.

4.6.1 Fatigue Analysis of the Suppression Chamber, Vents, and Downcomers

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

New hydrodynamic loads were identified subsequent to the original design for the containment suppression chamber vents. These additional loads result from blowdown into the suppression chamber during a postulated loss-of-coolant accident (LOCA) and during safety relief valve (SRV) operation during plant transients. The results of analyses of these effects were presented in the Plant Unique Analysis Report (PUAR) for each plant. The suppression chamber, and suppression chamber vents including the vent headers and downcomers were modified in order to reestablish the original design safety margins.

The Dresden and Quad Cities PUARs (Volumes 2 and 3) describe fatigue analyses of suppression chamber and suppression chamber vents, including the vent headers and downcomers. (References 4.5 and 4.6) Fatigue analyses of Class MC support members are included in the PUAR summaries of limiting-location usage factors. The analyses assumed a limited number of SRV actuations, based on a survey of plant data extrapolated to 40 years, and are therefore TLAAs.

Analysis

Dresden Suppression Chamber Shells and Associated Welds

There are five SRVs installed at Dresden and Quad Cities. The current design basis analysis assumed 300 SRV actuations of all five SRVs simultaneously during normal operation condition (NOC), plus 25 cycles for an intermediate-break accident (IBA) or 50 for a small-break accident (SBA) which ever was more bounding. The design basis also included an Operating Basis Earthquake (OBE) which was assumed the equivalent of 600 SRV cycles. The limiting analysis involves the 50 small break accidents rather the 25 cycles for an intermediate-break accident. In this limiting case, NOC + (SBA + OBE), the worst-location fatigue cumulative usage factor is 0.50 for the shells and 0.80 for the associated welds. SRV actuations are the largest contributor, 0.34, to the fatigue cumulative usage factor for the shells; and SBA + OBE is the largest contributor, 0.72, to the fatigue cumulative usage factor for the associated welds.

Dresden Suppression Chamber Vent Headers, Downcomers, and Associated Welds

The current design basis analysis assumed 550 SRV actuations of all five SRVs simultaneously during normal operation (NOC), plus 1000 cycles for OBE, plus 25 IBA or 50 SBA cycles. NOC + (SBA + OBE) is the limiting case, for which the worst-location fatigue cumulative usage factor is 0.92 for the vent headers (at the intersection with the downcomers) and 0.26 for the associated welds. The contribution of the SRV discharge loads to the fatigue cumulative usage factor of the vent headers and associated welds is insignificant (~ 0.00).

Quad Cities Suppression Chamber Shells and Associated Welds

The current design basis analysis assumed 550 SRV actuations of all five SRVs simultaneously during normal operation (NOC), plus 600 cycles for OBE, plus 25 IBA or 50 SBA cycles. NOC + (SBA + OBE) is the limiting case, for which the worst-location fatigue cumulative usage factor is 0.52 for the shells and 0.40 for the associated welds. SRV actuations and SBA + OBE are equal contributors to the fatigue cumulative usage factor for the shells, 0.25 from SRV and 0.27 from SBA + OBE. SRV actuations are the largest contributor, 0.26, to the fatigue cumulative usage factor for the associated welds.

Quad Cities Suppression Chamber Vent Headers, Downcomers, and Associated Welds

The current design basis assumed 550 SRV actuations of all five SRVs simultaneously during normal operation (NOC), plus 1000 cycles for OBE, plus 25 IBA or 50 SBA cycles. NOC + (SBA + OBE) is the limiting case, for which the worst-location usage factor is 0.92 for the vent headers (at the intersection with the downcomers) and 0.26 for the associated welds. The contribution of the SRV discharge loads to the usage factor of the vent headers and associated welds is insignificant (~ 0.00).

Table 4.6.1-1 presents the cumulative usage factors (CUFs) based on calculations using the above inputs. In addition, it assumes that each SRV "actuation" results in one thermal, one pressure, and five dynamic load cycles. However, for the vent header and associated welds, the effect of normal operating condition SRV discharge loads on the fatigue usage factor is insignificant.

Table 4.6.1-1 Summary of CUFs for Suppression Chamber Shell, Vent Header Including Vents and Welds

	Limiting 40-year CUF	Assumed SRV Actuations
Dresden Suppression Chamber Shell	0.50	300
Dresden Suppression Chamber Shell Associated Welds	0.80	300
Dresden Suppression Chamber Vent Header	0.92	550
Dresden Suppression Chamber Vent Header Associated Welds	0.26	550
Quad Cities Suppression Chamber Shell	0.52	550
Quad Cities Suppression Chamber Shell Associated Welds	0.40	550
Quad Cities Suppression Chamber Vent Header	0.92	550
Quad Cities Suppression Chamber Vent Header Associated Welds	0.26	550

Disposition: Validation, 10 CFR 54.21(c)(1)(i) and Aging Management, 10 CFR 54.21(c)(1)(iii)

For most shell, vent, and penetration locations, the predicted 40-year usage factor (CUF) is less than 0.666, and the analysis for that location is validated by

$$(U_{max,40} < 0.666) \times 60/40 \Rightarrow (U_{max,60} < 0.999), < 1.0$$

However, a CUF of 0.666 provides no analytical or event margin. This validation will therefore be applied only to locations with a calculated 40-year CUF less than 0.4. The locations whose 40-year CUF is at least 0.4 will be included in the aging management program, as described below.

Since only the SRV load cases contribute to fatigue during normal operation, normal operation may continue so long as the contribution from SRV discharges has not exceeded 1.0 minus the contribution expected from the postulated worst-case LOCA plus OBE event. The high-usage-factor locations in the containment shell, vents, and penetrations will be also managed by the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. Specifically, SRV lifts will be monitored to ensure that CUFs remain less than 1.0. For the primary containment, this program will monitor CUFs through Cycle-Based Fatigue Monitoring (CBF).

Cycle-based fatigue monitoring consists of a two step process: (a) automated cycle counting, and (b) CUF computation based on the counted cycles. The automated cycle counting counts each transient that is defined in the plant licensing basis based upon the mechanistic process or sequence of events experienced by the plant (as determined from monitored plant instruments). The approach is conservative because it assumes each actual transient has a severity equal to that assumed in the design basis. The unique severity of any transient identified by the aging management program software is captured for each monitored component, for ready comparison to design basis transient severity. Transients defined in the Dresden and Quad Cities UFSAR are identified and implemented into the aging management program software. CUF computation calculates fatigue directly from counted transients and parameters for the monitored components. CUF is computed via a design-basis fatigue calculation where the numbers of cycles are substituted for assumed design basis number of cycles. The CUF calculations are conservative in that design basis transient severity is assumed.

All governing fatigue analyses have been reviewed to establish a comprehensive and bounding set of Primary Containment locations for inclusion in the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. All locations with 40-year CUFs expected to exceed 0.4 will be included in the program. Those locations are listed in Table 4.6.1-2 below. The associated CUFs are all based upon the original 40 year analysis.

All necessary plant transient events will be tracked to ensure that the CUF remains less than 1.0 for all monitored components. In the event fatigue usage is predicted to exceed 1.0 for any component prior to 60 years of operation, appropriate corrective action will be taken in accordance with the Exelon Corrective Action Program (B.2.1). The required implementing actions will be completed prior to the period of extended operation.

Table 4.6.1-2 Fatigue Monitoring Locations for Primary Containment Components

Plant	Primary Containment Location	Fatigue Usage Factor
Dresden 2 and 3	Suppression Chamber Weld	0.800
Dresden 2 and 3	Vent Header at the Downcomer-Vent Header Intersection	0.920
Quad Cities 1 and 2	Suppression Chamber Shell	0.520

The locations listed above apply to all of our Quad Cities/Dresden Units and represent/bound all other locations for both plants.

4.6.2 Fatigue Analysis of SRV Discharge Piping Inside the Suppression Chamber, External Suppression Chamber Attached Piping, and Associated Penetrations

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

There are 5 safety relief valves (SRV) located on the main steam piping for each unit at Dresden and Quad Cities. When open, steam discharges from each SRV through piping routed through the drywell to the suppression chamber. The SRV discharge piping enters the suppression chamber through penetrations on the suppression chamber vent header where the steam is discharged to the suppression chamber water through a T-quencher attached to the suppression chamber. Additionally, there are a number of external piping systems attached to the suppression chamber shell. The Plant-Unique Analysis Reports for each site describe the fatigue analyses of SRV discharge lines, T-quenchers, the SRV discharge line penetrations through the vent lines, suppression chamber shell (torus) attached piping (TAP) systems, and the associated penetrations. These analyses assume a limited number of SRV actuations throughout the 40-year life for the plant and are therefore TLAAs.

Analysis

The suppression chamber assembly is often referred to as the "torus" and is used interchangeably with the phrase "suppression chamber" in the discussions that follow. The Dresden and Quad Cities analyses of fatigue effects of Mark I cyclic "new loads" on SRV discharge lines (SRVDL), internal to the suppression chamber, and on torus attached piping (TAP) external to the suppression chamber can be summarized as follows:

External TAP and Class 2 and 3 SRV Discharge Lines

Both the TAP and the SRV discharge lines in the suppression chamber are covered by a generic fatigue analysis for Class 2/3 piping which was submitted for NRC approval by the Mark I containment owners group. The generic analysis assumed 800 SRV actuations for a 40-year plant lifetime. Other thermal cycles due to normal operating conditions were considered to be negligible. The analysis concluded that the SRV discharge lines and TAP would have a fatigue cumulative usage factor of less than 0.5 at the end of 40 years of operation.

SRV Discharge Line-Vent Line Penetrations ("Sleeves") and Associated Sections of the SRV Discharge Lines

Fatigue analyses of these Class MC components shows that the maximum fatigue usage factors for these piping system locations are 0.18 for Quad Cities and 0.09 for Dresden (References 4.17 and 4.18). The analysis performed considered two separate cases in order to identify bounding analysis. Fatigue analyses assumed 220 SRV actuations for "Case 1," 110 for "Case 2."

Case 1: All 220 SRV actuations are single-valve first actuations (i.e. no subsequent actuations). This maximizes the number of cycles of full-range $|T_A - T_B|$ stress.

Case 2: 110 isolation events, each with 1 first actuation and 1 subsequent actuation. This maximizes the number of cycles in which mechanical and thermal expansion loads from a subsequent actuation add to the thermal transient stress from the first actuation.

Case 2 can result in a higher usage factor than the "220 actuation" Case 1: Case 2 is in fact not 110 "actuations" but 110 "events" of two actuations each, and upon analysis, the Case 2 event definition is found to include more-severe loads than Case 1.

Calculations of Class MC penetration components and attachments assumed 220 SRV actuations of 5 dynamic cycles each, plus 4,050 cycles due to condensation oscillation or chugging. The calculations determined the allowable alternating stress intensity S_A, from Figure I–9.0 of the ASME Code for that number of load cycles. This method did not calculate a usage factor, but instead limited the alternating stress intensity S_A to a value that ensured that the usage factor will remain less than 1.0 for the number of cycles assumed to occur during the design life.

<u>Analysis for ECCS Suction Strainer Modifications</u>

To address concerns associated with potential plugging and unacceptable head loss, ECCS suction strainers were replaced at Dresden and Quad Cities. Larger ECCS suction strainers required reinforcement of ECCS suction header-strainer penetrations X-303A, B, C, and D at Dresden and of penetrations X-204A, B, C, and D at Quad Cities Unit 2. The additional loads required revised analyses of the stress and fatigue effects.

The Dresden fatigue analyses of these ECCS penetrations were based on the generic Mark I owners group analysis. The analyses assumed 300 SRV actuations in 40 years, plus 25 cycles for intermediate-break accident (IBA) and 50 for a small-break accident (SBA). However, improvements in the SRV actuation load definition model permitted the significant stress reversals for each SRV actuation to be reduced from five to three. This revised analysis assumed five operating basis earthquake (OBE) events.

For Dresden Unit 2 the worst-location worst-case fatigue cumulative usage factors are 0.0836 at the suppression chamber insert-nozzle combination and 0.1423 at the corresponding pad, of which the largest contributions, 0.040 and 0.0571, respectively, are from the 300 normal-operating-condition (NOC) SRV events.

For Dresden Unit 3, the worst-location worst-case usage factors are 0.0570 at the suppression chamber insert-nozzle combination, and 0.0832 at the corresponding pad, of which the largest contributions, 0.0216 and 0.0348, respectively, are from the 300 NOC SRV events.

The Quad Cities Unit 2 fatigue analysis of these ECCS penetrations was based on generic analysis, MPR-751, "Mark I Owners Group Generic Fatigue Evaluation Report - 1982." The analysis assumed 550 SRV actuations in 40 years, plus 25 cycles for intermediate-break accident (IBA) and 50 for a small-break accident (SBA). However, improvements in the SRV actuation load definition model permitted the significant stress reversals for each actuation to be reduced from five to three. This revised analysis assumed five operating basis earthquake (OBE) events, in agreement with MPR-751. The worst-location worst-case maximum 40-year usage factor is 0.3087, of which the largest contribution, 0.1713, is from the 550 NOC SRV events.

Table 4.6.2-1 provides a summary of the maximum cumulative usage factors discussed for the suppression pool shell attached piping, SRV discharge lines, and penetrations. The analysis assumes that each SRV "actuation" results in one thermal, one pressure, and five (later reduced to three) dynamic load cycles. Note that at both plants, Case 2 is limiting. A CUF "<1.0" means the usage factor was not calculated. The calculation determined an S_A limit from the number of load cycles that ensures that the usage factor is less than 1.0.

Disposition: Validation, 10 CFR 54.21(c)(1)(i) and Aging Management, 10 CFR 54.21(c)(1)(iii)

For most safety relief valve (SRV) discharge lines, T-quenchers, the SRV discharge line penetrations through the vent lines, suppression chamber-attached piping (TAP) systems, and the associated penetration locations the predicted 40-year usage factor (CUF) is less than 0.666, and the analysis for that location is validated by

$$(U_{max,40} < 0.666) \times 60/40 \Rightarrow (U_{max,60} < 0.999), < 1.0$$

However, a CUF of 0.666 provides no analytical or event margin. Therefore, this validation will be applied only to locations with a calculated 40-year CUF less than 0.4. The locations whose 40-year CUF is at least 0.4, will be included in the aging management program, described below.

Since only the SRV load cases contribute to fatigue during normal operation, normal operation may continue so long as the contribution from SRV lifts has not exceeded 1.0 minus the contribution expected from the postulated worst-case LOCA plus OBE event. This will be confirmed for the duration of the extended operating period by monitoring fatigue at the high-usage-factor containment system locations using the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program. Specifically, SRV lifts will be monitored to ensure that CUFs remain less than 1.0 for the Dresden and Quad Cities Class MC SRVDL-Vent Line Penetration Components and Welds listed in Table 4.6.2-1. The Suppression Chamber Attached Piping (TAP) and Class 2 and 3 SRVDL's listed in Table 4.6.2-1 is bounded and covered by the suppression chamber shell which is monitored by the Metal Fatigue of Reactor Coolant Pressure Boundary (B.1.34) aging management program shown in Table 4.6.1-2. This program will be initiated prior to the period of extended operation.

Table 4.6.2-1 Summary of CUFs for Shell-Attached Piping, SRVDLs, and Penetrations

Scope	Limiting 40-year CUF	Assumed SRV Actuations
Suppression Chamber Attached Piping (TAP) and Class 2 and 3 SRVDLs	0.5	800, 5 cycles each
Dresden Class MC Portions of SRVDLs at the Vent Line Penetrations ("Sleeves")	0.061 0.093	Case 1: 220 Case 2: 110 events, 220 actuations@5 cycles each
Quad Cities Class MC Portions of SRVDLs at the Vent Line Penetrations ("Sleeves")	0.042 0.18	Case 1: 220 Case 2: 110 events, 220 actuations @5 cycles each
Dresden and Quad Cities Class MC SRVDL-Vent Line Penetration Components and Welds	<1.0 (See Note Below)	220, 5 cycles each, plus 4,050 OBE, chugging, and condensation oscillation (CO) cycles
Dresden Unit 2 Revised Class MC Analysis of ECCS Suction Penetrations for Strainer Modifications	Suppression chamber-insert-nozzle: 0.08 Pad plate: 0.14	300, 3 cycles each
Dresden Unit 3 Revised Class MC Analysis of ECCS Suction Penetrations for Strainer Modifications	Suppression Chamber, insert, nozzle: 0.06 Pad plate: 0.08	300, 3 cycles each
Quad Cities Unit 2 Revised Class MC Analysis of ECCS Suction Penetrations for Strainer Modifications	0.31	550, 3 cycles each

Note: A CUF "<1.0" means the usage factor was not calculated.

4.6.3 Drywell-to-Suppression Chamber Vent Line Bellows Fatigue Analyses

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The drywell-to-suppression chamber vent line bellows are included in the Mark I Containment Long-Term Program (LTP) plant-unique analyses. A fatigue analysis of the drywell-to-suppression chamber vent line bellows demonstrates their adequacy to accommodate thermal and internal pressure load cycles for the life of the plant.

Analysis

Mark I containment designs include a drywell-to-suppression chamber vent line. A bellows assembly is provided at the penetration of the vent line to the suppression chamber. The bellows allows differential movement of the vent system and suppression chamber to occur without developing significant interaction loads. The analysis of the drywell-to-suppression chamber vent line bellows assumed a total of 150 load cycles for the life of the plant. The bellows are adequate for fatigue since the bellows have a rated capacity of 1,000 cycles at maximum displacement.

Dresden has external vacuum breakers which include 24-inch bellows at their penetration attachment. Quad Cities has no corresponding bellows configuration. The bellows of the external vacuum breakers are included in the vent system analysis. The differences between Dresden and Quad Cities include the external vacuum breakers. The effect of these differences in the overall vent system analysis was found to be insignificant, and therefore the Dresden analyses were based on Quad Cities geometry. An NRC SER concluded that the owner's review of the Dresden external vacuum breakers to the stress criteria of ASME III Division 1 Subsection NC (1977, Summer 1977 Addenda) demonstrated that the design is adequate. (Reference 4.7) "The fatigue usage factors in the vacuum breakers and their attachments, (and at Dresden, their penetrations) are therefore bounded by other analyzed locations and are not limiting."

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

For the vent line bellows, 150 thermal and internal pressure load cycles were specified for the life of the plant. The expected total load cycles for the extended operation period would therefore be 150 x (60/40) = 225 cycles. This is less than 25 percent of the rated capacity of 1000 cycles. The fatigue adequacy of these bellows is therefore validated.

The rated capacity of the drywell-to-shell vent line bellows is adequate for the number of pressure and temperature cycles expected during the extended licensed operating period.

4.6.4 Primary Containment Process Penetrations Bellows Fatigue Analysis

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

Containment pipe penetrations that must accommodate thermal movement have expansion bellows. The bellows are designed for a minimum number of operating thermal cycles over the design life at containment normal, test, and limiting design pressures.

Analysis

At Dresden and Quad Cities the only containment process piping expansion joints are those between the drywell shell penetrations and process piping subject to significant thermal expansion and contraction. These containment penetration process bellows have been designed for 7000 operating and thermal cycles.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

Thermal cycles on the bellows are imposed by thermal cycles experienced by the attached piping. The assumed thermal cycle count for the analyses used in the codes associated with piping and components can conservatively be approximated by the thermal cycles used in the reactor vessel fatigue analysis. These thermal cycles are listed in UFSAR Table 3.9-1. The total count of all these listed thermal cycles is less than 2200 for a 40-year plant. For the 60-year extended operating period, the number of thermal cycles for piping analyses would be proportionally increased to less than 3300, a fraction of the 7000-cycle threshold. The containment penetration bellows fatigue analysis is therefore valid for the 60-year extended operating period.

4.7 OTHER PLANT-SPECIFIC TLAAS

NUREG-1801 identifies numerous aging effects that require evaluation as possible TLAAs in accordance with 10 CFR 54.21(c). Each of these is summarized in NUREG-1800 and presented in Section 3 of this LRA and referenced to the appropriate TLAA section.

Section 4.7 of this application contains a discussion on the following plant-specific TLAAs:

- Reactor Building Crane Load Cycles
- Metal Corrosion Allowances
    - Corrosion Allowances for Power Operated Relief Valves
    - Degradation Rates of Inaccessible Exterior Drywell Plate Surfaces
    - Galvanic Corrosion in the Containment Shell and Attached Piping Components Due to Stainless Steel ECCS Suction Strainers
- Crack Growth Calculation of a Postulated Flaw in the Heat Affected Zone of an Arc Strike in the Containment Shell
- Radiation Degradation of Drywell Shell Expansion Gap Polyurethane Foam

High-Energy Line Break postulation based on fatigue cumulative usage factor is listed as a possible TLAA in NUREG-1800. However, this is not a TLAA for either Dresden or Quad Cities. Section 4.7.5 provides addition information supporting this conclusion.

4.7.1 Reactor Building Crane Load Cycles

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The reactor building overhead cranes at Dresden and Quad Cities were designed to meet or exceed the design fatigue loading requirements of the Crane Manufacturers Association of America (CMAA) Specification 70, Class A1. This evaluation of expected cycles over the 40-year life is the basis of a safety determination and is therefore a TLAA.

Analysis

The service classification for the reactor building overhead crane is CMAA Class A1 and is designed for 100,000 loading cycles. The weldments are categories B and C, which permit a stress range of 28,000 - 33,000 psi (References 4.3 and 4.4).

The maximum allowable stress in the girders with rated load is 17,600 PSI and the minimum stress (no load) is approximately 2,400 PSI. The maximum stress range in the girders will not exceed 15,200 PSI. Since the maximum stress permitted in other weldments is 14,000 PSI, they have a smaller range and better fatigue resistance than the girders. These ranges are satisfactory for approximately 2 million loading cycles. This would be equivalent to approximately 50,000 125-ton loads per year handled in the center of span over a 40-year period.

It is estimated that these cranes will see fewer than 5,000 cycles at rated capacity and a larger number of cycles at significantly less than rated capacity. For this reason, fatigue life is not significant to the operation of this equipment (References. 4.19, 4.20, and 4.21).

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The reactor building cranes are designed to CMAA-70 Class A1. The design evaluations show that all components are qualified for 100,000 loading cycles (i.e., 100,000 lifts at rated capacity). The 40-year estimated cycles are at most 5,000 rated-capacity load cycles and 7,500 if extended to a 60-year life. The 60-year 7,500-cycle estimate remains a small fraction of the 100,000 cycle minimum design. Therefore, fatigue life is not significant to the operation of this equipment and remains valid for the period of extended operation.

4.7.2 Metal Corrosion

General corrosion is the result of a chemical or electrochemical reaction between a material and an aggressive environment. General corrosion is normally characterized by uniform attack resulting in material dissolution and sometimes corrosion product buildup. The metal can thin down and fail by either penetration or lack of cross sectional area to support the required load. Certain plant components have a design life limited by corrosion rates. As such, these design limitations may be a TLAA.

Section 4.7.2 of the application addresses the following corrosion related TLAAs:

- Corrosion Allowance for Power Operated Relief Valves
- Degradation Rates of Inaccessible Exterior Drywell Plate Surfaces
- Galvanic Corrosion in the Containment Shell and Attached Piping Components Due to Stainless Steel ECCS Suction Strainers

4.7.2.1 Corrosion Allowance for Power Operated Relief Valves

Applicability

This section applies to Quad Cities Unit 2 only.

Summary Description

Power Operated Relief Valves (PORVs) installed on the Quad Cities Unit 2 reactor coolant pressure boundary for overpressurization relief replacement PORVs were designed with a corrosion allowance valid for 40 years of operation. The specification is cited in Quad Cities UFSAR Section 5.22 and as such, the corrosion design allowance for the PORVs is a TLAA.

Analysis

A modification was installed on Quad Cities Unit 2 to replace the main steam line electromatic relief valves with PORVs. The electromatic relief valves were replaced for purposes other than general corrosion damage. The specification for the PORVs is cited in Quad Cities UFSAR § 5.2.2. The replacement PORVs were designed with a corrosion allowance designed for 40 years of operation. The corrosion rate and allowances remain applicable for the remaining design life.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The PORVs were installed on Quad Cities Unit 2 in 1995. Since the valves were installed more than 20 years into the current license, the values remain valid for the period of extended operation.

4.7.2.2 Degradation Rates of Inaccessible Exterior Drywell Plate Surfaces

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The Mark I containment design includes an inaccessible "sand pocket" around the drywell. The potential for degradation of the containment exists due to conditions that allow the introduction of water into the annulus (expansion gap) between the containment and the primary containment shield wall. Water can be introduced due to leakage of the refuel cavity past the refueling bellows drain line expansion joints during refueling or due to the introduction of water at other drywell penetrations. This water migrates to the sand pocket under the bottom elevation of the containment and then passes through the sand pocket drain lines. If the drain lines become clogged, the water remains in the sand pocket and creates an environment that may be corrosive to the containment steel plates.

In response to Generic Letter 87-05, "Potential Degradation of Mark I Drywell," Dresden and Quad Cities projected corrosion rates for the steel drywell plates in this area and determined that the wall thickness was sufficient for the remainder of the 40-year license period. The evaluation of remaining life of the drywell steel thickness based on a specified corrosion rate is a TLAA.

Analysis

In response to Generic Letter 87-05, both Dresden and Quad Cities performed an inspection of the drain lines on all four units to detect leakage in the pocket region. As a result of these actions, it was determined that the sand pocket drains were clogged on Dresden Unit 3 and an evaluation of actual plate thickness was performed on this unit.

The design of the Dresden Unit 3 containment vessel is such that margin exists between the required shell thickness and the actual thickness of the steel plate provided. A reevaluation of the required shell thickness in the region of the sand pocket was performed based on loads and data compatible with the original certified containment vessel stress report by Chicago Bridge & Iron Company. It was determined that the thickness of the plates in the sand pocket region may be reduced to approximately ¼ inch below the nominal and still be within ASME Code allowable stress limits.

Actual UT thickness measurements were made of the Dresden Unit 3 drywell steel plate at the sand pocket level. All thickness measurements were on the high side (above the nominal 1.0625 inch). The measurements were taken during the 18^{th} year of operation for Dresden Unit 3. In response to GL 87-05, conservative estimates of corrosion rates that might occur were made. Starting with the minimum as-found steel plate thickness of 1.08 inch and assuming a corrosion rate of 0.01 inch per year, it was concluded that 27 years of service would remain before the effects of corrosion on stresses would become significant. The corrosion rate was based upon a worst case rate of 10 mils per year for fresh river water.

The final response to Generic Letter 87-05 concluded that the amount of moisture found in the sand pocket drains at Quad Cities was negligible in comparison to Dresden Unit 3 and that it was not expected that any corrosion occurred on either unit. The final response also concluded that there was no reason to expect adverse thickness of the drywell liner on Dresden Unit 2. However, the Dresden Unit 3 plate thickness estimates were used to bound Dresden Unit 2 and both units at Quad Cities. The conservatively analyzed years of service life (18 + 27 = 45) would not be sufficient for the extended license period.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

The corrosion rate assumptions used in the calculation will be confirmed by a UT inspection prior to the period of extended operation. The inspection will be performed at Dresden and the results will be used to revise the corrosion calculation and validate that an acceptable wall thickness will remain to the end of the 60 year license operating period.

4.7.2.3 Galvanic Corrosion in the Containment Shell and Attached Piping Components due to Stainless Steel ECCS Suction Strainers

Applicability

This section applies to Dresden and Quad Cities

Summary Description

To address concerns associated with potential plugging and unacceptable head loss, Exelon replaced the ECCS suction strainers at Dresden and Quad Cities. This modification resulted in contact between the carbon steel support flanges and stainless steel components. The effects of galvanic corrosion on these components were evaluated in a calculation. The evaluation of the effects of galvanic corrosion on the ECCS suction strainer flanges and other components in containment shell is based on a predicted corrosion rate for the plant lifetime, and is a TLAA.

Analysis

The modification to install larger ECCS strainers required drilling new bolt holes and enlarging existing bolt holes in each of the original strainer support flanges to provide sufficient bolting for the larger replacement strainers. The holes drilled in the carbon steel flanges were not coated to protect them from corrosion. Previously, coatings prevented contact and corrosion loss. The existing design calculation for the modified strainer support flanges assumes a corrosion loss of 4 mils/year for 33 years which is not sufficient to encompass the entire period of extended operation.

Disposition: Revision, 10 CFR 54.21(c)(1)(ii)

The corrosion rate assumptions used in the calculation will be confirmed by a ultrasonic inspection prior to the period of extended operation. One bounding inspection will be performed and results will be used to validate the corrosion rate for both sites. Based upon the results of the inspection, a revised galvanic corrosion calculation will be performed to ensure acceptable wall thickness to the end of the 60-year licensed operating period.

4.7.3 Crack Growth Calculation of a Postulated Flaw in the Heat Affected Zone of an Arc Strike in the Suppression Chamber Shell

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

Dresden and Quad Cities evaluated the effect of an arc strike flaw on the suppression chamber wall based on a common analysis. Postulated crack growth rates due to operation were evaluated to be acceptable over a 40-year life.

No other flaw evaluation TLAAs were found for Dresden and Quad Cities.

Analysis

In 1990, arc strikes found in the Dresden and Quad Cities suppression chamber walls were evaluated using a common analysis. The evaluation included a crack growth calculation and assumed 850 load cycles due to SRV and other operations in 40 years of plant life. A further evaluation was performed in 1997 and it was determined that the flaw depth of the arc strike at Dresden was not of sufficient depth to warrant any final repairs. Assuming an operating limit of 850 SRV load cycles, no further action was warranted. A UT measurement was performed at Quad Cities that validated that there is no flaw in the heat affected zone of the original arc strike. An evaluation was performed and it was determined that further repairs or inspections were not warranted.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

The number of SRV actuations used in the Quad Cities containment analysis is 550 for 40 years compared with the 850 actuations assumed in the flaw evaluation calculation. The expected number of SRV actuations from the year the flaw was repaired, 1990, to the end of the extended operating period in 2032 would be at most (550/40) x (2032-1990) = 577.5 <850. Therefore the evaluation remains valid for Quad Cities for the extended period of operation.

The number of SRV actuations used in the Dresden containment analysis is 300 for 40 years compared with the 850 actuation assumed in the flaw evaluation calculation, the Dresden TLAA can be validated similarly. The current license for Dresden Unit 3 will expire in 2011, and the Dresden flaw was repaired in 1991. The expected number of SRV actuations from the year the flaw was repaired to the end of the extended operating period in 2031 would be at most (300/40) x (2031-1991) = 300 <850. Therefore the evaluation remains valid for Dresden for the extended period of operation.

4.7.4 Radiation Degradation of Drywell Shell Expansion Gap Polyurethane Foam

Applicability

This section applies to Dresden and Quad Cities.

Summary Description

The steel drywell shell is largely enclosed within the structural and shielding concrete of the reactor building. To accommodate thermal expansion, compressible foam was used to form an expansion gap between the concrete and the drywell shell. An analysis evaluated the increase in external compressive loads on the drywell exterior, due to additional compression of this foam, for normal, refuel, and accident conditions. The effect on this analysis of a postulated increase in the foam stiffness resulting from radiation dose is a TLAA.

Analysis:

The polyurethane foam material was chosen for its resistance to the environmental conditions likely to exist during its service life. The polyurethane foam was chosen such that the effects of compression during a loss of coolant accident resulting in thermal expansion of the drywell would not exceed ASME Code allowable limits. Polyurethane foam samples, similar to those used in the gap, were irradiated in a test lab at various levels, from 10^7 and 10^9 rads. The test results established that there was no detectable change in resilience below 10^8 rads. The original design considered the effects of a 40-year lifetime dose of 2.5×10^7 rads on the foam material. As such, the resilient characteristics of the polyurethane foam will remain in tact during the 40-year design life.

Disposition: Validation, 10 CFR 54.21(c)(1)(i)

A 20-year increase in the design lifetime to 60 years, combined with approved increases in power rating, would conservatively result in a total radiation exposure of 4.2 $\times 10^7$ rads. This is less than half of the 10^8 rads qualified radiation exposure. Therefore, the material properties will remain within the limits assumed by the original design analysis, in accordance with the aging assumptions assumed by the original design, for the 60-year extended operating period.

4.7.5 High-Energy Line Break Postulation Based on Fatigue Cumulative Usage Factor

Summary Description

This issue is included only because it is listed as a possible TLAA in NUREG-1800. Neither Dresden nor Quad Cities postulated break locations are based on a fatigue usage factor criterion, nor are any break locations based on any other evaluation of fatigue effects. This is not a TLAA for either Dresden or Quad Cities.

4.8 REFERENCES

4.1 USNRC *Supplemental Safety Evaluation Regarding the Proposed Core Shroud Repair - Quad Cities Nuclear Power Station, Units 1 and 2 (TAC Nos. M91301 and M91302).*" Attached to a letter from R. M. Pulsifer (USNRC) to D. L. Farrar (ComEd), September 11, 1995.

4.2 USNRC *Safety Evaluation by the Office of Nuclear Reactor Regulation, GE Nuclear Energy Topical Report NEDC-32983P, 'General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluations,' Project No. 710.* Attached to NRC Letter MFN 01-050, Stuart A. Richards, Director, Project Directorate IV, to James F. Klapproth, Manager, Engineering and Technology, GE Nuclear Energy, "Safety Evaluation for NEDC-32983P, 'General Electric Methodology for Reactor Pressure Vessel Fast Neutron Flux Evaluation,' (TAC No. MA9891)," September 14, 2001.

4.3 *Dresden Station Updated Final Safety Analysis Report,* Revision 4. Exelon Nuclear: 2001. Cited throughout this chapter as "Dresden UFSAR."

4.4 *Quad Cities Station Updated Final Safety Analysis Report,* Revision 6. Exelon Nuclear: 2001. Cited throughout this chapter as "Quad Cities UFSAR."

4.5 *Dresden Nuclear Power Station Units 2 and 3 Plant Unique Analysis Report.* Volumes 1-4, 6, and 7, NUTECH Engineers, Inc. Report COM-02-041, May 1983. Volume 5, Sargent and Lundy, June 1983.

4.6 *Quad Cities Nuclear Power Station Units 1 and 2, Mark I Plant Unique Analysis Report.* Volumes 1-4, 6, and 7, NUTECH Engineers, Inc. Report COM-02-039, May 1983. Volume 5, Sargent and Lundy, June 1983

4.7 Dresden SER 861219, *Safety Evaluation by the Office of Nuclear Reactor Regulation Relating to Mark I Containment Program - Vacuum Breaker Integrity, Commonwealth Edison Company, Dresden Nuclear Power Station Units 2 and 3, Docket Nos.: 50-237 and 249.* With attached Franklin Research Center Technical Evaluation Report TER-C5506-324, *Structural Evaluation of the Vacuum Breakers (Mark I Containment Program), Commonwealth Edison Company, Dresden Nuclear Power Station Units 2 and 3,* July 17, 1986; and attached Continuum Dynamics, Inc. Tech Note No. 84-30, *Mark I Wetwell to Drywell Differential Pressure Load and Vacuum Breaker Response for the Dresden Nuclear Power Station Units 2 and 3,* Revision 0, January 1985. All attached to an NRC Letter, John A. Zwolinski, Director, BWR Project Directorate #1, Division of BWR Licensing, to Dennis L. Farrar, Director of Nuclear Licensing, Commonwealth Edison, "Structural Integrity of Vacuum Breakers (TAC 57152 and 57153)," December 19, 1986.

4.8 Ranganath, S., "Fracture Mechanics Evaluation of a Boiling Water Reactor Vessel Following a Postulated Loss of Coolant Accident," Fifth International Conference on Structural Mechanics in Reactor Technology, Berlin, Germany, August 1979, Paper G1/5.

This work was docketed as an attachment to a PP&L letter of October 8, 1991 for Dockets 50-387 and 50-388 (Susquehanna Steam Electric Station) and its attached "Response to Request for Additional Information Enforcement Action 89-042 on Reactor Vessel Cooldown Rate," Revision 0, October 10, 1991 [PDR ACN 9910110101]. This RAI response cites the work as "GE SASR 89-40 Reference 7-9." The GE report is

> General Electric Report SASR 89-40, "Pressure-Temperature Curve Basis for Susquehanna Steam Electric Station Units 1 and 2," June 1989.

General Electric Report SASR 89-40 contains proprietary information belonging to both General Electric and PP&L, and has not been released or reviewed. This Susquehanna citation is however an example of application of the 1979 Ranganath paper to a BWR-4, although the sample case was a BWR-6.

4.9 General Electric Document Y1002A602, "304 Stainless Steel, Irradiated," Revision 3, October 16, 1985.

4.10 General Electric Nuclear Energy NEDO-32962 Revision 1, DRF A22-00103-13, Class I, August 2001, "Safety Analysis Report for Dresden 2 & 3 Extended Power Uprate"

4.11 General Electric Nuclear Energy NEDO-32961 Revision 1, DRF A22-00103-13, Class I, August 2001, "Safety Analysis Report for Quad Cities 1 & 2 Extended Power Uprate"

4.12 ASTM Special Technical Publication No. 426, *The Effects of Radiation on Structural Materials.* Philadelphia: ASTM, 1966. (Cited by D and QC UFSAR § 3.9.5.3.2, not separately reviewed.)

4.13 L. A. Waldman and M. Doumas, "Fatigue and Burst Tests on Irradiated In-Pile Stainless Steel Pressure Tubes," *Nuclear Applications,* Vol. 1, October 1965. (Cited by D and QC UFSAR § 3.9.5.3.2, not separately reviewed.)

4.14 BWRVIP-05, EPRI Report TR-105697, *BWR Vessel and Internals Project, BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations (BWRVIP-05).* For the Boiling Water Reactor Owners Group (Proprietary), September 28, 1995, with supplementing letters of June 24 and October 29, 1996, May 16, June 4, June 13, and December 18, 1997, and January 13, 1998. Cited by the SRP-LR [NUREG 1800,] as Section 4.2 Reference 4. (EPRI Proprietary Information)

4.15 BWRVIP-05 SER (Final), USNRC letter from Gus C. Lainas to Carl Terry, Niagara Mohawk Power Company, BWRVIP Chairman, "Final Safety Evaluation of the BWRVIP Vessel and Internals Project BWRVIP-05 Report," (TAC No. M93925), July 28, 1998. Cited by the SRP-LR [NUREG 1800] as Section 4.2 Reference 5.

4.16 BWRVIP-05 SER (Supplement), USNRC letter from Jack R. Strosnider, Jr., to Carl Terry, BWRVIP Chairman, "Supplement to Final Safety Evaluation of the BWRVIP Vessel and Internals Project BWRVIP-05 Report," (TAC No. MA3395), March 7, 2000.

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