BWR CONTAINMENTS

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B1. MARK I CONTAINMENTS

B1.1 Steel Containments

B1.1.1 Steel Elements

B1. MARK I CONTAINMENTS

Systems, Structures, and Components

This section addresses the elements of BWR Mark I containment structures. Mark I steel containments are discussed in II.B1.1.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and standby gas treatment system (V.B). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B2) and feedwater system (VIII.D2), or is supported by the containment structure. The containment structure basemat may provide support to the NSSS components and containment internal structures.

II Containment Structures
B1.1 BWR Mark I Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.1.1-a	Steel elements: Drywell; torus; drywell head; embedded shell and sand pocket regions; drywell support skirt; torus ring girder; downcomers; ECCS suction header NOTE: Inspection of containment supports is addressed by ASME Section XI, Subsection IWF (see III.B1.3)	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner. 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
B1.1 BWR Mark I Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No
B1.1.1-b	Steel elements: Torus; vent line; vent header; vent line bellows; downcomers	Stainless steel; carbon steel	Inside or outside containment	Cracking / Cyclic loading (CLB fatigue analysis does not exist)	Chapter XI.S1 "ASME Section XI, Subsection IWE " and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* VT-3 visual inspection may not detect fine cracks.	Yes, detection of aging effects is to be evaluated
B1.1.1-c	Steel elements: Torus; vent line; vent header; vent line bellows; downcomers	Stainless steel; carbon steel	Inside or outside containment	Cumulative fatigue damage / Fatigue (Only if CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.6, "Containment Liner Plate and Penetration Fatigue Analysis" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA

II Containment Structures
B1.1 BWR Mark I Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.1.1-d	Steel elements: Vent line bellows	Stainless steel	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE " and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* Stress corrosion cracking (SCC) is a concern for dissimilar metal welds. In the case of bellows assemblies, SCC may cause aging effects particularly if the material is not shielded from a corrosive environment. Subsection IWE covers inspection of these items under examination categories E-B, E-F, and E-P (10 CFR Part 50, Appendix J pressure tests). 10 CFR 50.55a identifies examination categories E-B and E-F as optional during the current term of operation. For the extended period of operation, Examination Categories E-B and E-F, and additional appropriate examinations to detect SCC in bellows assemblies and dissimilar metal welds are warranted to address this issue. *(10) Operating Experience:* IN 92-20 describes an instance of containment bellows cracking, resulting in loss of leak tightness.	Yes, detection of aging effects is to be evaluated
B1.1.1-e	Steel elements: Drywell head; downcomers	Carbon steel; graphite plate	Inside or outside containment	Fretting or lockup / Mechanical wear	Chapter XI.S1, "ASME Section XI, Subsection IWE"	No

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B2. MARK II CONTAINMENTS

B2.1 Steel Containments

B2.1.1 Steel Elements

B2.2 Concrete Containments

B2.2.1 Concrete Elements
B2.2.2 Steel Elements
B2.2.3 Prestressing System

B2. MARK II CONTAINMENTS

Systems, Structures, and Components

This section addresses the elements of BWR Mark II containment structures. Mark II steel containments are discussed in II.B2.1. Mark II concrete containments are discussed in II.B2.2.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and standby gas treatment system (V.B). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B2) and feedwater system (VIII.D2), or is supported by the containment structure. The containment structure basemat may provide support to the NSSS components and containment internal structures.

II Containment Structures
B2.1 BWR Mark II Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.1.1-a	Steel elements: Drywell; suppression chamber; drywell head; embedded shell and sand pocket regions; support skirt; downcomer pipes; region shielded by diaphragm floor NOTE: Inspection of containment supports is addressed by ASME Section XI, Subsection IWF (see III.B1.3).	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner. 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
B2.1 BWR Mark II Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No
B2.1.1-b	Steel elements: Suppression pool shell, unbraced downcomers	Carbon steel	Inside or outside containment	Cracking / Cyclic loading (CLB fatigue analysis does not exist)	Chapter XI.S1 "ASME Section XI, Subsection IWE " and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* VT-3 visual inspection may not detect fine cracks.	Yes, detection of aging effects is to be evaluated
B2.1.1-c	Steel Elements: Suppression pool shell, unbraced downcomers	Carbon steel	Inside or outside containment	Cumulative fatigue damage / Fatigue (Only if CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.6, "Containment Liner Plate and Penetration Fatigue Analysis" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA
B2.1.1-d	Steel elements: Drywell head; downcomer pipes	Carbon steel	Inside or outside containment	Fretting or lockup / Mechanical wear	Chapter XI.S1, "ASME Section XI, Subsection IWE"	No

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.1-a	Concrete elements: Containment; basemat	Concrete	Outside containment	Increase in porosity, permeability / Leaching of calcium hydroxide	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: Leaching of calcium hydroxide from reinforced concrete becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well-cured, has low permeability, and that cracking is well controlled. Cracking is controlled through proper arrangement and distribution of reinforcing bars. All of the above characteristics are assured if the concrete was constructed with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of leaching of calcium hydroxide. Inaccessible Areas: For below grade inaccessible areas (basemat and concrete wall), a plant-specific aging management program is required only if the above conditions are not satisfied.	Yes, if leaching of calcium hydroxide is significant for inaccess-ible areas
B2.2.1-b	Concrete elements: Containment; basemat	Concrete	Inside or outside containment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For interior and above-grade exterior reinforced concrete, aggressive chemical attack is not significant if the concrete is not exposed to an	Yes, if aggressive chemical attack is significant for inaccess-ible areas

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) aggressive environment (pH < 5.5), or to chloride or sulfate solutions beyond defined limits (> 500 ppm chloride, or > 1,500 ppm sulfate). Inspections performed in accordance with IWL will indicate the absence or presence of aggressive chemical attack. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.1-c	Concrete elements: Containment; basemat	Concrete	Inside or outside containment	Cracking due to expansion / Reaction with aggregates	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, investigations, tests, and petrographic examinations of aggregates performed in accordance with ASTM C295-54 or ASTM C227-50 can demonstrate that those aggregates do not react within reinforced concrete. For potentially reactive aggregates, aggregate-reinforced concrete reaction is not significant if the concrete was constructed in accordance with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of surface degradation due to reaction with aggregates.	No
B2.2.1-d	Concrete elements: Containment; basemat; reinforcing steel	Concrete; carbon steel	Inside or outside containment	Cracking, loss of bond, and loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S2, "ASME Section XI, Subsection IWL," Accessible Areas: For exterior above-grade and interior embedded steel, corrosion is not significant if the steel is not exposed to an aggressive environment (concrete pH < 11.5 or chlorides > 500 ppm). Alternatively, if the environment surrounding the concrete is non-aggressive (pH > 5.5, chlorides < 500 ppm, sulfates < 1,500 ppm), corrosion of embedded steel is not significant. If such steel is exposed to an aggressive environment, corrosion is not significant	Yes, if corrosion of embedded steel is significant for inaccess-ible areas

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) if the concrete in which the steel is embedded has a low water-to-cement ratio (0.35-0.45), adequate air entrainment (3-6%), low permeability, and is designed in accordance with ACI 318-63 (or later edition) or ACI 349-85 (or later edition). Inspections performed in accordance with IWL will indicate the absence or presence of visible corrosion of embedded steel. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.1-e	Concrete elements: All	Concrete	Inside or outside containment	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S6, "Structures Monitoring Program" The initial Licensing Basis for some plants included a program to monitor settlement. If no settlement was evident during the first decade or so, the NRC may have given the licensee approval to discontinue the program. However, if a de-watering system is relied upon for control of settlement, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation	No, if within the scope of the applicant's structures monitoring program
B2.2.1-f	Concrete elements: Foundation; subfoundation	Concrete; porous concrete	Flowing water under foundation	Reduction in foundation strength, cracking, differential settlement / Erosion of porous concrete subfoundation	Chapter XI.S6, "Structures Monitoring Program" Erosion of cement from porous concrete subfoundations beneath containment basemats is described in IN 97-11. IN 98-26 proposes Maintenance Rule Structures Monitoring for managing this aging effect, if applicable. If a de-watering system is relied upon for control of erosion of cement from porous concrete subfoundations, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.1-g	Concrete elements: Containment; concrete fill in annulus; basemat	Concrete	Inside or outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program. The implementation of 10 CFR 50.55a and IWL would not be able to identify the reduction of strength and modulus due to elevated temperature. Thus, for any portions of concrete containment that exceed specified temperature limits, further evaluations are warranted. Subsection CC-3400 of ASME Section III, Division 2, specifies the concrete temperature limits for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are not allowed to exceed 200°F. If significant equipment loads are supported by concrete at temperatures exceeding 150°F, an evaluation of the ability to withstand the postulated design loads is to be made. Higher temperatures than given above may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and this reduction is applied to the design allowables.	Yes, if applicable

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.2-a	Steel elements: Drywell; suppression chamber; basemat liners; liner anchors; drywell head; downcomer pipes NOTE: Inspection of containment supports is addressed by ASME Section XI, Subsection IWF (see III.B1.3).	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner. 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program."	No No
B2.2.2-b	Steel elements: Suppression chamber liner (interior surface)	Stainless steel	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J"	No
B2.2.2-c	Steel elements: Vent header; downcomers	Carbon steel	Inside or outside containment	Cracking / Cyclic loading (CLB fatigue analysis does not exist)	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* VT-3 visual inspection may not detect fine cracks.	Yes, detection of aging effects is to be evaluated
B2.2.2-d	Steel elements: Vent header; downcomers	Carbon steel	Inside or outside containment	Cumulative fatigue damage / Fatigue (Only if CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.6, "Containment Liner Plate and Penetration Fatigue Analysis," for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA

II Containment Structures
B2.2 BWR Mark II Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.2.2-e	Steel elements: Drywell head; downcomer pipes	Carbon steel	Inside or outside containment	Fretting or lockup / Mechanical wear	Chapter XI.S1, "ASME Section XI, Subsection IWE"	No
B2.2.3-a	Prestressing system: Tendons; anchorage components	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S2, "ASME Section XI Subsection IWL"	No
B2.2.3-b	Prestressing system: Tendons; anchorage components	Carbon steel	Inside or outside containment	Loss of prestress / Relaxation; shrinkage; creep; elevated temperature	Loss of tendon prestress is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.5, "Concrete Containment Tendon Prestress" for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii). See Chapter X.S1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii). For periodic monitoring of prestress, see Chapter XI.S2.	Yes, TLAA

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B3. MARK III CONTAINMENTS

B3.1 Steel Containments

B3.1.1 Steel Elements
B3.1.2 Concrete Elements

B3.2 Concrete Containments

B3.2.1 Concrete Elements
B3.2.2 Steel Elements

B3. MARK III CONTAINMENTS

Systems, Structures, and Components

This section addresses the elements of BWR Mark III containment structures. Mark III steel containments are discussed in II.B3.1. Mark III concrete containments are discussed in II.B3.2.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and standby gas treatment system (V.B). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B2) and feedwater system (VIII.D2), or is supported by the containment structure. The containment structure basemat may provide support to the NSSS components and containment internal structures.

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B3.1.1-a	Steel elements: Containment shell; suppression chamber shell; basemat liner; liner anchors	Carbon steel	Inside or Outside Containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner. 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No
B3.1.1-b	Steel elements: Suppression chamber shell (interior surface)	Stainless steel	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J"	No
B3.1.2-a	Concrete elements: Basemat	Concrete	Outside containment	Increase in porosity, permeability / Leaching of calcium hydroxide	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: Leaching of calcium hydroxide from reinforced concrete becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well-cured, has low permeability, and that cracking is well controlled. Cracking is controlled through proper arrangement and distribution of reinforcing bars. All of the above characteristics are assured if the concrete was constructed with the guidance of ACI 201.2R-77. Inspections	Yes, if leaching of calcium hydroxide is significant for inaccess-ible areas

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) performed in accordance with IWL will indicate the absence or presence of leaching of calcium hydroxide. Inaccessible Areas: For below grade inaccessible areas (basemat and concrete wall), a plant-specific aging management program is required only if the above conditions are not satisfied.	
B3.1.2-b	Concrete elements: Basemat	Concrete	Inside or outside containment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For interior and above-grade exterior reinforced concrete, aggressive chemical attack is not significant if the concrete is not exposed to an aggressive environment (pH < 5.5), or to chloride or sulfate solutions beyond defined limits (> 500 ppm chloride, or > 1,500 ppm sulfate). Inspections performed in accordance with IWL will indicate the absence or presence of aggressive chemical attack. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of	Yes, if aggressive chemical attack is significant for inaccess-ible areas

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
B3.1.2-c	Concrete elements: Basemat; concrete fill in annulus	Concrete	Inside or outside containment	Cracking due to expansion / Reaction with aggregates	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, investigations, tests, and petrographic examinations of aggregates performed in accordance with ASTM C295-54 or ASTM C227-50 can demonstrate that those aggregates do not react within reinforced concrete. For potentially reactive aggregates, aggregate-reinforced concrete reaction is not significant if the concrete was constructed in accordance with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of surface degradation due to reaction with aggregates.	No

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B3.1.2-d	Concrete elements: Basemat; reinforcing steel	Concrete; carbon steel	Inside or outside containment	Cracking, loss of bond, and loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For exterior above-grade and interior embedded steel, corrosion is not significant if the steel is not exposed to an aggressive environment (concrete pH < 11.5 or chlorides > 500 ppm). Alternatively, if the environment surrounding the concrete is non-aggressive (pH > 5.5, chlorides < 500 ppm, sulfates < 1,500 ppm), corrosion of embedded steel is not significant. If such steel is exposed to an aggressive environment, corrosion is not significant if the concrete in which the steel is embedded has a low water-to-cement ratio (0.35-0.45), adequate air entrainment (3-6%), low permeability, and is designed in accordance with ACI 318-63 (or later edition) or ACI 349-85 (or later edition). Inspections performed in accordance with IWL will indicate the absence or presence of visible corrosion of embedded steel. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of	Yes, if corrosion of embedded steel is significant for inaccess-ible areas

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
B3.1.2-e	Concrete elements: Basemat	Concrete	Inside or outside containment	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S6, "Structures Monitoring Program" The initial Licensing Basis for some plants included a program to monitor settlement. If no settlement was evident during the first decade or so, the NRC may have given the licensee approval to discontinue the program. However, if a de-watering system is relied upon for control of settlement, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B3.1.2-f	Concrete elements: Foundation; subfoundation	Concrete; porous concrete	Flowing water under foundation	Reduction in foundation strength, cracking, differential settlement / Erosion of porous concrete subfoundation	Chapter XI.S6, "Structures Monitoring Program" Erosion of cement from porous concrete subfoundations beneath containment basemats is described in IN 97-11. IN 98-26 proposes Maintenance Rule Structures Monitoring for managing this aging effect, if applicable. If a de-watering system is relied upon for control of erosion of cement from porous concrete subfoundations, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program
B3.1.2-g	Concrete elements: Basemat; concrete fill in annulus	Concrete	Inside or outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program The implementation of 10 CFR 50.55a and IWL would not be able to identify the reduction of strength and modulus due to elevated temperature. Thus, for any portions of concrete containment that exceed specified temperature limits, further evaluations are warranted. Subsection CC-3400 of ASME Section III, Division 2, specifies the concrete temperature limits for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are not allowed to exceed 200°F. If significant equipment loads are supported by concrete at temperatures exceeding 150°F, an	Yes, if applicable

II Containment Structures
B3.1 BWR Mark III Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) evaluation of the ability to withstand the postulated design loads is to be made. Higher temperatures than given above may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and this reduction is applied to the design allowables.	

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B3.2.1-a	Concrete elements: Dome; wall; basemat	Concrete	Outside containment	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, freeze-thaw does not cause loss of material from reinforced concrete in foundations, and in above and below grade exterior concrete, for plants located in a geographic region of negligible weathering conditions (weathering index <100 day-inch/yr). Loss of material from such concrete is not significant at plants located in areas in which weathering conditions are severe (weathering index >500 day-inch/yr) or moderate (100-500 day-inch/yr), provided that the concrete mix design meets the air content (entrained air 3-6%) and water-to-cement ratio (0.35-0.45) specified in ACI 318-63 (or later edition) or ACI 349-85 (or later edition). The weathering index is defined in ASTM C33-90, Table 3, Footnote E. Fig. 1 of ASTM C33-90 illustrates the various weathering index regions throughout the U.S.	No
B3.2.1-b	Concrete elements: Dome; wall; basemat	Concrete	Outside containment	Increase in porosity, permeability / Leaching of calcium hydroxide	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: Leaching of calcium hydroxide from reinforced concrete becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is	Yes, if leaching of calcium hydroxide is significant for inaccess-ible areas

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) constructed to ensure that it is dense, well-cured, has low permeability, and that cracking is well controlled. Cracking is controlled through proper arrangement and distribution of reinforcing bars. All of the above characteristics are assured if the concrete was constructed with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of leaching of calcium hydroxide. Inaccessible Areas: For below grade inaccessible areas (basemat and concrete wall), a plant-specific aging management program is required only if the above conditions are not satisfied.	
B3.2.1-c	Concrete elements: Dome; wall; basemat	Concrete	Inside or outside containment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For interior and above-grade exterior reinforced concrete, aggressive chemical attack is not significant if the concrete is not exposed to an aggressive environment (pH $<$ 5.5), or to chloride or sulfate solutions beyond defined limits ($>$ 500 ppm chloride, or $>$ 1,500 ppm sulfate). Inspections performed in accordance with IWL will indicate the absence or presence of aggressive chemical attack.	Yes, if aggressive chemical attack is significant for inaccess-ible areas

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
B3.2.1-d	Concrete elements: Dome; wall; basemat	Concrete	Inside or outside containment	Cracking due to expansion / Reaction with aggregates	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, investigations, tests, and petrographic examinations of aggregates performed in accordance with ASTM C295-54 or ASTM C227-50 can demonstrate that those aggregates do not react within reinforced concrete. For potentially reactive aggregates, aggregate-reinforced concrete reaction is not significant if the concrete was	No

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) constructed in accordance with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of surface degradation due to reaction with aggregates.	
B3.2.1-e	Concrete elements: Dome; wall; basemat; reinforcing steel	Concrete; carbon steel	Inside or outside containment	Cracking, loss of bond, and loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For exterior above-grade and interior embedded steel, corrosion is not significant if the steel is not exposed to an aggressive environment (concrete pH < 11.5 or chlorides > 500 ppm). Alternatively, if the environment surrounding the concrete is non-aggressive (pH > 5.5, chlorides < 500 ppm, sulfates < 1,500 ppm), corrosion of embedded steel is not significant. If such steel is exposed to an aggressive environment, corrosion is not significant if the concrete in which the steel is embedded has a low water-to-cement ratio (0.35-0.45), adequate air entrainment (3-6%), low permeability, and is designed in accordance with ACI 318-63 (or later edition) or ACI 349-85 (or later edition). Inspections performed in accordance with IWL will indicate the absence or presence of visible corrosion of embedded steel.	Yes, if corrosion of embedded steel is significant for inaccess-ible areas

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
B3.2.1-f	Concrete elements: All	Concrete	Inside or outside containment	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S6, “Structures Monitoring Program” The initial Licensing Basis for some plants included a program to monitor settlement. If no settlement was evident during the first decade or so, the NRC may have given the licensee approval to discontinue the program. However, if a de-watering system is relied upon for control of settlement, then the licensee is to ensure proper functioning of the	No, if within the scope of the applicant’s structures monitoring program

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) dewatering system through the period of extended operation.	
B3.2.1-g	Concrete elements: Foundation; subfoundation	Concrete; porous concrete	Flowing water under foundation	Reduction in foundation strength, cracking, differential settlement / Erosion of porous concrete subfoundation	Chapter XI.S6, "Structures Monitoring Program" Erosion of cement from porous concrete subfoundations beneath containment basemats is described in IN 97-11. IN 98-26 proposes Maintenance Rule Structures Monitoring for managing this aging effect, if applicable. If a de-watering system is relied upon for control of erosion of cement from porous concrete subfoundations, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program
B3.2.1-h	Concrete elements: Dome; wall; basemat	Concrete	Inside or outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program The implementation of 10 CFR 50.55a and IWL would not be able to identify the reduction of strength and modulus due to elevated temperature. Thus, for any portions of concrete containment that exceed specified temperature limits, further evaluations are warranted. Subsection CC-3400 of ASME Section III, Division 2, specifies the concrete temperature limits for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are not allowed to	Yes, if applicable

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) exceed 200°F. If significant equipment loads are supported by concrete at temperatures exceeding 150°F, an evaluation of the ability to withstand the postulated design loads is to be made. Higher temperatures than given above may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and this reduction is applied to the design allowables.	
B3.2.2-a	Steel elements: Containment liner ; suppression chamber liner ; basemat liner ; liner anchors	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
B3.2 BWR Mark III Concrete Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required. Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance program"	 No No
B3.2.2-b	Steel elements: Suppression chamber liner (interior surface)	Stainless steel	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J"	No

B4. COMMON COMPONENTS

B4.1 Penetration Sleeves, Penetration Bellows, Dissimilar Metal Welds

B4.2 Personnel Airlock, Equipment Hatch, Control Rod Drive (CRD) Hatch

B4.3 Seals, Gaskets, and Moisture Barriers

B4. COMMON COMPONENTS

Systems, Structures, and Components

This section addresses the common components of BWR containments. The common components include penetration sleeves and bellows; dissimilar metal welds; personnel airlock; equipment hatch; CRD hatch; and seals, and gaskets, and moisture barriers.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and standby gas treatment system (V.B). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B2) and feedwater system (VIII.D2), or is supported by the containment structure. The containment structure basemat may provide support to the NSSS components and containment internal structures.

II Containment Structures
B4 BWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B4.1-a	Penetration sleeves	Carbon steel; dissimilar metal welds	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" (Note: IWE examination category E-F, surface examination of dissimilar metal welds, is optional) Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No No
B4.1-b	Penetration sleeves; penetration bellows	Carbon steel, stainless steel; dissimilar metal welds	Inside or outside containment	Cumulative fatigue damage / Fatigue (Only if CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.6, "Containment Liner Plate and Penetration Fatigue Analysis," for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA

II Containment Structures
B4 BWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B4.1-c	Penetration sleeves; penetration bellows	Carbon steel; stainless steel dissimilar metal welds	Inside or outside containment	Cracking / Cyclic loading (CLB fatigue analysis does not exist)	Chapter XI.S1 "ASME Section XI, Subsection IWE " and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* VT-3 visual inspection may not detect fine cracks.	Yes, detection of aging effects is to be evaluated
B4.1-d	Penetration sleeves; penetration bellows	Stainless steel; dissimilar metal welds	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* Stress corrosion cracking (SCC) is a concern for dissimilar metal welds. In the case of bellows assemblies, SCC may cause aging effects particularly if the material is not shielded from a corrosive environment. Subsection IWE covers inspection of these items under examination categories E-B, E-F, and E-P (10 CFR Part 50, Appendix J pressure tests). 10 CFR 50.55a identifies examination categories E-B and E-F as optional during the current term of operation. For the extended period of operation, Examination Categories E-B & E-F, and additional appropriate examinations to detect SCC in bellows assemblies and dissimilar	Yes, detection of aging effects is to be evaluated

II Containment Structures
B4 BWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) metal welds are warranted to address this issue. *(10) Operating Experience:* IN 92-20 describes an instance of containment bellows cracking, resulting in loss of leak tightness.	
B4.2-a	Personnel airlock; equipment hatch; CRD hatch	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" Chapter XI.S4, "10 CFR Part 50, Appendix J" If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program."	No No No
B4.2-b	Personnel airlock; equipment hatch; CRD hatch: Locks, hinges, and closure mechanisms	Carbon steel	Inside or outside containment	Loss of leak tightness in closed position / Mechanical wear of locks, hinges and closure mechanisms	Chapter XI.S4, "10 CFR Part 50, Appendix J" and Plant Technical Specifications	No

II Containment Structures
B4 BWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B4.3-a	Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Various	Inside or outside containment	Loss of sealing; leakage through containment / Deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Chapter XI.S1, "ASME Section XI, Subsection IWE" Leak tightness will be monitored by 10 CFR Part 50, Appendix J Leak Rate Tests for pressure boundary, seals and gaskets (including O-rings).	No