CHAPTER III

STRUCTURES AND COMPONENT SUPPORTS

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STRUCTURES AND COMPONENT SUPPORTS

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CLASS 1 STRUCTURES

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A1.1 Concrete Elements

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A1. GROUP 1 STRUCTURES (BWR REACTOR BLDG., PWR SHIELD BLDG., CONTROL RM./BLDG.)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of BWR reactor building, PWR shield building, and control room/building. For this group, the applicable structural elements are concrete, steel, and masonry walls. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems or components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-a	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-b	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-d	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-e	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides >500ppm, or sulfates > 1500 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.	Yes, if an aggressive below-grade environment exists
A1.1-f	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-g	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A1.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in groundwater conditions	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

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-i	Concrete: Foundation; subfoundation	Reinforced 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
A1.1-j	Concrete: All	Reinforced concrete	Outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program For any concrete elements that exceed specified temperature limits, further evaluations are warranted. Appendix A of ACI 349-85 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 which are allowed to have increased temperatures not to exceed 200°F.	Yes, if applicable

III Structures and Component Supports
A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A1.3-a	Masonry walls: All	Concrete block	Ambient environment inside building	Cracking / Restraint; shrinkage; creep; aggressive environment	Chapter XI.S5, "Masonry Wall Program"	No

A2. GROUP 2 STRUCTURES (BWR REACTOR BLDG. WITH STEEL SUPERSTRUCTURE)

A2.1 Concrete Elements

A2.2 Steel Elements

A2.3 Masonry Walls

A2. GROUP 2 STRUCTURES (BWR REACTOR BLDG. WITH STEEL SUPERSTRUCTURE)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of BWR reactor building with steel superstructure. For this group, the applicable structural elements are identified: concrete, steel, and masonry walls. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-a	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-b	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-d	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-e	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A2.1-f	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-g	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500ppm, or sulfates >1500ppm). 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.	Yes, if an aggressive below-grade environment exists
A2.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in ground-water conditions	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

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-i	Concrete: Foundation; subfoundation	Reinforced 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
A2.1-j	Concrete: All	Reinforced concrete	Outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program For any concrete elements that exceed specified temperature limits, further evaluations are warranted. Appendix A of ACI 349-85 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 which are allowed to have increased temperatures not to exceed 200°F.	Yes, if applicable

III Structures and Component Supports
A2. Group 2 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Room/Bldg.)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A2.3-a	Masonry walls: All	Concrete block	Ambient environment inside building	Cracking / Restraint; shrinkage; creep; aggressive environment	Chapter XI.S5, "Masonry Wall Program"	No

A3. GROUP 3 STRUCTURES (AUXILIARY BLDG., DIESEL GENERATOR BLDG., RADWASTE BLDG., TURBINE BLDG., SWITCHGEAR RM., AFW PUMPHOUSE, UTILITY/PIPING TUNNELS)

A3.1 Concrete Elements

A3.2 Steel Elements

A3.3 Masonry Walls

A3. GROUP 3 STRUCTURES (AUXILIARY BLDG., DIESEL GENERATOR BLDG., RADWASTE BLDG., TURBINE BLDG., SWITCHGEAR RM., AFW PUMPHOUSE, UTILITY/PIPING TUNNELS)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of auxiliary building, diesel generator building, radwaste building, turbine building, switchgear room, AFW pumphouse, and utility/piping tunnels. For this group, the applicable structural elements are identified: concrete, steel, and masonry walls. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-a	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-b	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-d	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-e	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500ppm). 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.	Yes, if an aggressive below-grade environment exists
A3.1-f	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, “Structures Monitoring Program” As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant’s structures monitoring program

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-g	Concrete: Below-grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A3.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in ground-water conditions	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

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-i	Concrete: Foundation; subfoundation	Reinforced 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
A3.1-j	Concrete: All	Reinforced concrete	Outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program For any concrete elements that exceed specified temperature limits, further evaluations are warranted. Appendix A of ACI 349-85 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 which are allowed to have increased temperatures not to exceed 200°F.	Yes, if applicable

III Structures and Component Supports

A3. Group 3 Structures (Auxiliary, Diesel Generator, Radwaste, and Turbine Buildings; Switchgear Room, AFW Pumphouse, Utility/Piping Tunnels)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A3.3-a	Masonry walls: All	Concrete block	Ambient environment inside building	Cracking / Restraint; shrinkage; creep; aggressive environment	Chapter XI.S5, "Masonry Wall Program"	No

A4. GROUP 4 STRUCTURES (CONTAINMENT INTERNAL STRUCTURES, EXCLUDING REFUELING CANAL)

A4.1 Concrete Elements

A4.2 Steel Elements

A4. GROUP 4 STRUCTURES (CONTAINMENT INTERNAL STRUCTURES, EXCLUDING REFUELING CANAL)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of containment internal structures, excluding refueling canal. For this group, the applicable structural elements are identified: concrete and steel elements. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A4. Group 4 Structures (Containment Internal Structures, Excluding Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A4.1-a	Concrete: All	Reinforced concrete	Inside containment, exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program
A4.1-b	Concrete: All	Reinforced concrete	Inside containment	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A4. Group 4 Structures (Containment Internal Structures, Excluding Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A4.1-c	Concrete: All	Reinforced concrete	Inside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program For any concrete elements that exceed specified temperature limits, further evaluations are warranted. Appendix A of ACI 349-85 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 which are allowed to have increased temperatures not to exceed 200°F.	Yes, if applicable
A4.1-d	Concrete: All	Reinforced concrete	Inside containment, exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, “Structures Monitoring Program” As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant’s structures monitoring program

III Structures and Component Supports
A4. Group 4 Structures (Containment Internal Structures, Excluding Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A4.2-a	Steel components: All structural steel	Carbon steel	Inside containment	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A4.2-b	Steel components: Radial beam seats in BWR drywell; RPV support shoes for PWR with nozzle supports	Lubrite	Inside containment	Lock-up / Wear	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

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A5. GROUP 5 STRUCTURES (FUEL STORAGE FACILITY, REFUELING CANAL)

A5.1 Concrete Elements

A5.2 Steel Elements

A5.3 Masonry Walls

A5. GROUP 5 STRUCTURES (FUEL STORAGE FACILITY, REFUELING CANAL)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of fuel storage facility and refueling canal. For this group, the applicable structural elements are identified: concrete, steel, and masonry walls. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-a	Concrete Exterior above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of Material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-b	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-d	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-e	Concrete: Fuel storage facility below grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A5.1-f	Concrete: Interior and above-grade exterior	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-g	Concrete: Fuel storage facility below grade exterior; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A5.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in ground-water conditions	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

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.1-i	Concrete: Foundation; subfoundation	Reinforced 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
A5.1-j	Concrete: All	Reinforced concrete	Outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program For any concrete elements that exceed specified temperature limits, further evaluations are warranted. Appendix A of ACI 349-85 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 which are allowed to have increased temperatures not to exceed 200°F.	Yes, if applicable

III Structures and Component Supports
A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A5.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A5.2-b	Steel components: Liners	Stainless steel	Exposed to water	Crack initiation and growth, Loss of material / Stress corrosion cracking and crevice corrosion	Chapter XI.M2, "Water Chemistry Program" and monitoring of the spent fuel pool water level	No
A5.3-a	Masonry walls: Fuel storage facility	Concrete block	Ambient environment inside building	Cracking / Restraint; shrinkage; creep; aggressive environment	Chapter XI.S5, "Masonry Wall Program"	No

A6. GROUP 6 STRUCTURES (WATER-CONTROL STRUCTURES)

A6.1 Concrete Elements

A6.2 Steel Elements

A6.3 Masonry Walls

A6.4 Earthen Water-Control Structures

A6. GROUP 6 STRUCTURES (WATER-CONTROL STRUCTURES)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of water-control structures. For this group, the applicable structural elements are identified: concrete, steel, masonry walls, and earthen water-control structures. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-a	Concrete: Exterior above and below grade; foundation; interior slab	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-b	Concrete: Exterior above and below grade; foundation; interior slab	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-d	Concrete: All	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-e	Concrete: All	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-f	Concrete: All	Reinforced concrete	Soft soil; changes in ground-water conditions	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance 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
A6.1-g	Concrete: Foundation; subfoundation	Reinforced 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

III Structures and Component Supports
A6. Group 6 Structures (Water-Control Structures)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A6.1-h	Concrete: Exterior above and below grade; foundation; interior slab	Reinforced concrete	Flowing water	Loss of material / Abrasion; cavitation	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance	No
A6.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants" or the FERC / US Army Corp of Engineers dam inspections and maintenance If protective coatings are relied upon to manage the effects of aging, this AMP is to include requirements to address protective coating monitoring and maintenance.	No
A6.3-a	Masonry walls: Intake structure; cooling tower	Concrete block	Various	Cracking / Restraint; shrinkage; creep; aggressive environment	Chapter XI.S5, "Masonry Wall Program"	No
A6.4-a	Earthen water-control structures: Dams, embankments, reservoirs, channels, canals	Various	Weather exposed, standing and flowing water	Loss of material, loss of form / Erosion, settlement, sedimentation, frost action, waves, currents, surface runoff, seepage	Chapter XI.S7, "Regulatory Guide 1.127, Inspection of Water-Control Structures Associated with Nuclear Power Plants " or the FERC / US Army Corp of Engineers dam inspections and maintenance.	No

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A7. GROUP 7 STRUCTURES (CONCRETE TANKS)

A7.1 Concrete Elements

A7.2 Steel Elements

A7. GROUP 7 STRUCTURES (CONCRETE TANKS)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of concrete tanks. For this group, the applicable structural elements are identified: concrete and steel. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-a	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-b	Concrete: Exterior above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-c	Concrete: All	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-d	Concrete: Exterior above grade	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-e	Concrete: Exterior below grade; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A7.1-f	Concrete: Exterior above grade	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-g	Concrete: Exterior below grade; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500ppm). 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.	Yes, if an aggressive below-grade environment exists
A7.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in groundwater conditions	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

III Structures and Component Supports
A7. Group 7 Structures (Concrete Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A7.1-i	Concrete: Foundation; subfoundation	Reinforced 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
A7.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A7.2-b	Steel components: Liner	Stainless steel	Exposed to fluid environment (water, fuel)	Crack initiation and growth, loss of material / Stress corrosion cracking, crevice corrosion	Plant-specific aging management program	Yes

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A8. GROUP 8 STRUCTURES (STEEL TANKS)

A8.1 Concrete Elements

A8.2 Steel Elements

A8. GROUP 8 STRUCTURES (STEEL TANKS)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of steel tanks. For this group, the applicable structural elements are identified: concrete and steel. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A8. Group 8 Structures (Steel Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A8.1-a	Concrete: Foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A8. Group 8 Structures (Steel Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A8.1-b	Concrete: Foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A8. Group 8 Structures (Steel Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A8.1-c	Concrete: Foundation	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program
A8.1-d	Concrete: Foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists

III Structures and Component Supports
A8. Group 8 Structures (Steel Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A8.1-e	Concrete: Foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A8.1-f	Concrete: Foundation	Reinforced concrete	Soft soil; changes in groundwater conditions	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

III Structures and Component Supports
A8. Group 8 Structures (Steel Tanks)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A8.1-g	Concrete: Foundation; subfoundation	Reinforced 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
A8.2-a	Steel components: All structural steel	Carbon steel	Various	Loss of material / Corrosion	Chapter XI.S6, "Structures Monitoring Program" If protective coatings are relied upon to manage the effects of aging, the structures monitoring program is to include requirements to address protective coating monitoring and maintenance.	No, if within the scope of the applicant's structures monitoring program
A8.2-b	Steel components: Liner	Stainless steel	Exposed to fluid environment	Crack initiation and growth, loss of material / Stress corrosion cracking, crevice corrosion	Plant-specific aging management program	Yes

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A9. GROUP 9 STRUCTURES (BWR UNIT VENT STACK)

A9.1 Concrete Elements

A9. GROUP 9 STRUCTURES (BWR UNIT VENT STACK)

Systems, Structures, and Components

Class 1 structures are organized into nine groups and are discussed separately under subheadings A1 through A9. This section addresses the elements of BWR unit vent stack. For this group, the applicable structural elements are identified: concrete. The aging management review is presented for each applicable combination of structural element and aging effect.

System Interfaces

Physical interfaces exist with any system or component that either penetrates the structure wall or is supported by the structure wall, floor, and roof. The direct interface is through the system or component supports that are anchored to the structure. Structures also protect housed systems and components from internal and external design basis events. In the case of tanks, there is a functional interface with the associated system. Water-control structures are integral parts of the systems that provide plant cooling water and residual heat removal.

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-a	Concrete: Above and below grade; foundation	Reinforced concrete	Weather exposed	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required. 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, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-b	Concrete: Above and below grade; foundation	Reinforced concrete	Flowing water	Increase in porosity and permeability, loss of strength / Leaching of calcium hydroxide	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, 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. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-c	Concrete: Above and below grade; foundation	Reinforced concrete	Any	Expansion and cracking / Reaction with aggregates	Chapter XI.S6, "Structures Monitoring Program" 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 ACI 201.2R-77. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-d	Concrete: Above grade	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, corrosion of exterior above-grade and interior embedded steel is not significant if the steel is not exposed to an aggressive environment (concrete pH <11.5 or chlorides >500 ppm). 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 ACI 349-85. Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-e	Concrete: Below grade; foundation	Reinforced concrete	Exposure to aggressive environment	Cracking, loss of bond, loss of material (spalling, scaling) / Corrosion of embedded steel	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A9.1-f	Concrete: Above grade	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S6, "Structures Monitoring Program" As described in NUREG-1557, aggressive chemical attack on interior and above-grade exterior reinforced concrete 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 >1500 ppm sulfate). Therefore, if these conditions are satisfied, aging management is not required.	No, if within the scope of the applicant's structures monitoring program

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-g	Concrete: Below grade; foundation	Reinforced concrete	Exposure to aggressive environment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	A plant-specific aging management program is required only if the below-grade environment is aggressive (pH <5.5, chlorides >500 ppm, or sulfates >1500 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.	Yes, if an aggressive below-grade environment exists
A9.1-h	Concrete: All	Reinforced concrete	Soft soil; changes in groundwater conditions	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

III Structures and Component Supports
A9. Group 9 Structures (BWR Unit Vent Stack)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A9.1-i	Concrete: Foundation; subfoundation	Reinforced 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

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