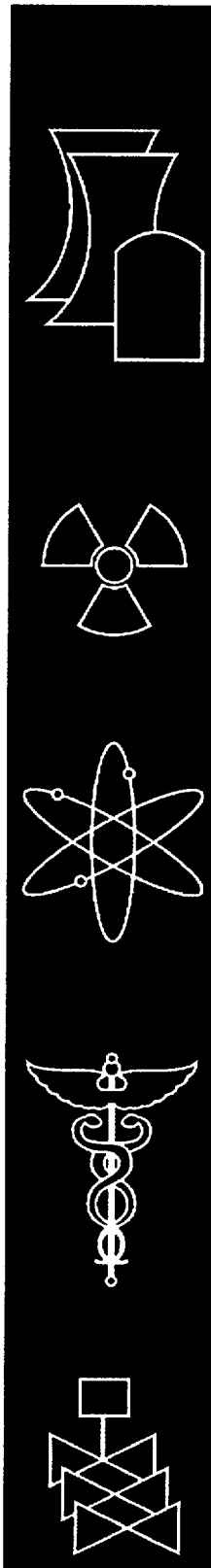

Generic Aging Lessons Learned (GALL) Report

Tabulation of Results

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

NUREG-1801, Vol. 2

Generic Aging Lessons Learned (GALL) Report

Tabulation of Results

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Abstract

The Generic Aging Lessons Learned (GALL) report contains the staff's generic evaluation of the existing plant programs and documents the technical basis for determining where existing programs are adequate without modification and where existing programs should be augmented for the extended period of operation. The evaluation results documented in the GALL report indicate that many of the existing programs are adequate to manage the aging effects for particular structures or components for license renewal without change. The GALL report also contains recommendations on specific areas for which existing programs should be augmented for license renewal. An applicant may reference the GALL report in a license renewal application to demonstrate that the programs at the applicant's facility correspond to those reviewed and approved in the GALL report and that no further staff review is required. The focus of the staff review is on the augmented existing programs for license renewal. The incorporation of the GALL report information into the NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," as directed by the Commission, should improve the efficiency of the license renewal process.

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LIST OF CONTRIBUTORS – 1999-2001

License Renewal and Standardization Branch
Office of Nuclear Reactor Regulation

P. T. Kuo	Section Chief
S. Lee	Team Leader
R. Anand	Technical Support
T. Bloomer	Technical Coordination (on rotation)
S. Chey	Clerical Support
M. Comar	Technical Support (on rotation)
J. Dozier	Technical Coordination
R. Franovich	Technical Coordination (on rotation)
S. Green	Clerical Support
S. Hoffman	Technical Support
P. Kang	Technical Coordination
E. Kleeh	Technical Coordination (on rotation)
S. Koenick	Technical Support
W. Liu	Technical Support
S. K. Mitra	Technical Coordination
K. Rico	Technical Coordination
D. Solorio	Technical Coordination
J. Strnisha	Technical Coordination
O. Tabatabai-Yazdi	Technical Coordination
H. Wang	Technical Support

Office of Nuclear Reactor Regulation

H. Ashar	Structural Engineering
G. Bagchi	Technical Coordination
M. Banic	Materials Engineering
C. Berlinger	Technical Coordination
C. Carpenter	Materials Engineering
P. Y. Chen	Technical Coordination
T. Cheng	Structural Engineering
S. Coffin	Materials Engineering
J. Davis	Materials Engineering
D. Dorman	Quality Assurance
T. Eaton	Plant Systems Engineering
B. Elliot	Materials Engineering
J. Fair	Mechanical Engineering
D. Frumkin	Plant Systems Engineering
G. Galletti	Quality Assurance
G. Georgiev	Materials Engineering
C. Gratton	Plant Systems Engineering
F. Grubelich	Mechanical Engineering
M. Hartzman	Mechanical Engineering
R. Hermann	Materials Engineering
A. Hiser	Materials Engineering
C. Holden	Electrical Engineering

LIST OF CONTRIBUTORS – 1999-2001 (continued)

Office of Nuclear Reactor Regulation (continued)

S. Hou	Materials Engineering
N. Iqbal	Plant Systems Engineering
D. Jeng	Structural Engineering
K. Karwoski	Materials Engineering
Y. Kim	Structural Engineering
W. Koo	Materials Engineering
C. Lauron	Materials Engineering
A. Lee	Structural Engineering
Y. Li	Mechanical Engineering
J. Ma	Structural Engineering
K. Manoly	Structural Engineering
J. Medoff	Materials Engineering
K. Parczewski	Chemical Engineering
P. Patnaik	Material Engineering
J. Peralta	Quality Assurance
J. Rajan	Mechanical Engineering
P. Shemanski	Electrical Engineering
E. Sullivan	Materials Engineering
J. Tatum	Plant Systems Engineering
B. Thomas	Plant Systems Engineering
E. Weiss	Plant Systems Engineering
S. West	Plant Systems Engineering
K. Wichman	Materials Engineering

Office of Nuclear Regulatory Research

J. Vora	Team Leader
A. Beranek	Technical Editor
J. Boardman	Reactor Systems Engineering
J. Costello	Structural Engineering
M. Dey	Reliability and Risk Analyst
O. Gormley	Mechanical Engineering
H. Graves	Structural Engineering
C. Hsu	Mechanical Engineering
D. Jackson	Materials Engineering
B. Jones	Nuclear Engineering
M. Kirk	Materials Engineering
R. Lloyd	Reactor Systems Engineering
M. McNeil	Materials Engineering
J. Muscara	Metallurgical Engineering
H. Ornstein	Reactor Systems Engineering
S. Pullani	Reactor Systems Engineering
A. Serkiz	Mechanical Engineering
K. Shaukat	Mechanical Engineering
M. Wegner	Reactor Systems Engineering

LIST OF CONTRIBUTORS – 1999-2001 (continued)

Office of the General Counsel

J. Euchner	Legal Counsel
B. Poole	Legal Counsel
R. Weisman	Legal Counsel
M. Young	Legal Counsel

Argonne National Laboratory

Y. Y. Liu	Principal Investigator
K. Brown	Technical Editor
O. Chopra	Materials Engineering
D. Diercks	Materials Engineering
R. Fabian	Quality Assurance
D. Henley	Mechanical Engineering
A. Hull	Materials Engineering
L. Kickels	Clerical Support
D. Ma	Mechanical Engineering
J. Robson	Clerical Support
L. Salinas	Clerical Support
K. Schroeder	Clerical Support
R. Seidensticker	Mechanical Engineering
W. Shack	Materials Engineering
V. Skonicki	Clerical Support
V. Shah	Materials and Mechanical Engineering
B. Shelton	Reactor and Plant Systems Engineering
S. Tam	Materials Engineering

Brookhaven National Laboratory

R. Morante	Principal Investigator
P. Bezler	Mechanical Engineering
J. Braverman	Containment Structures
G. DeGrassi	Mechanical Engineering
C. Hofmayer	Structural Engineering
R. Lofaro	Electrical Components
S. Shteyngart	Clerical Support
S. Signorelli	Clerical Support
M. Subudhi	Mechanical Engineering
M. Villaran	Electrical Engineering
J. Xu	Structural Engineering

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ABBREVIATIONS

ACI	American Concrete Institute
ADS	automatic depressurization system
AFW	auxiliary feedwater
ALARA	as low as reasonably achievable
AMP	aging management program
AMR	aging management review
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
B&PV	boiler and pressure vessel
B&W	Babcock & Wilcox
BWR	boiling water reactor
BWRVIP	Boiling Water Reactor Vessel and Internals Project
CASS	cast austenitic stainless steel
CB	core barrel
CCCW	closed-cycle cooling water
CE	Combustion Engineering
CEA	control element assembly
CEDM	control element drive mechanism
CFR	Code of Federal Regulations
CFS	core flood system
CLB	current licensing basis
CRD	control rod drive
CRDM	control rod drive mechanism
CRDRL	control rod drive return line
CRGT	control rod guide tube
CVCS	chemical and volume control system
DC	direct current
DHR	decay heat removal
DSCSS	drywell and suppression chamber spray system
ECP	electrochemical potential
EDG	emergency diesel generator
EFPD	effective full power day
EPRI	Electric Power Research Institute
EQ	environmental qualification
FAC	flow-accelerated corrosion
FERC	Federal Energy Regulatory Commission
FSAR	Final Safety Analysis Report
FW	feedwater
GALL	Generic Aging Lessons Learned
GE	General Electric
GL	generic letter

ABBREVIATIONS (continued)

HELBs	high-energy line breaks
HP	high pressure
HPCI	high-pressure coolant injection
HPCS	high-pressure core spray
HPSI	high-pressure safety injection
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
IASCC	irradiation assisted stress corrosion cracking
IC	isolation condenser
ID	inside diameter
IEB	inspection and enforcement bulletin
IEEE	Institute of Electrical and Electronics Engineers
IGA	intergranular attack
IGSCC	intergranular stress corrosion cracking
IN	information notice
INPO	Institute of Nuclear Power Operations
IPA	integrated plant assessment
IR	insulation resistance
IRM	intermediate range monitor
ISI	inservice inspection
ITG	Issues Task Group
LER	licensee event report
LG	lower grid
LOCA	loss of coolant accident
LP	low pressure
LPCI	low-pressure coolant injection
LPCS	low-pressure core spray
LPM	loose part monitoring
LPRM	low-power range monitor
LPSI	low-pressure safety injection
LRT	leak rate test
LWR	light water reactor
MFW	main feedwater
MIC	microbiologically influenced corrosion
MS	main steam
MSR	moisture separator/reheater
MT	magnetic particle testing
NDE	nondestructive examination
NEI	Nuclear Energy Institute
NFPA	National Fire Protection Association
NPAR	nuclear plant aging research
NPS	nominal pipe size
NRC	Nuclear Regulatory Commission
NRMS	normalized root mean square

ABBREVIATIONS (continued)

NSAC	Nuclear Safety Analysis Center
NSSS	nuclear steam supply system
NUMARC	Nuclear Management and Resources Council
OCCW	open-cycle cooling water
OD	outside diameter
ODSCC	outside diameter stress corrosion cracking
OM	operation and maintenance
PT	penetrant testing
PWR	pressurized water reactor
PWSCC	primary water stress corrosion cracking
QA	quality assurance
RCCA	rod control cluster assemblies
RCIC	reactor core isolation cooling
RCP	reactor coolant pump
RCPB	reactor coolant pressure boundary
RCS	reactor coolant system
RG	Regulatory Guide
RHR	residual heat removal
RICSIL	rapid information communication services information letter
RMS	root mean square
RWC	reactor water cleanup
RWST	refueling water storage tank
RWT	refueling water tank
SAW	submerged arc weld
SC	suppression chamber
SCC	stress corrosion cracking
SDC	shutdown cooling
SFP	spent fuel pool
SG	steam generator
S/G	standards and guides
SIL	services information letter
SIT	safety injection tank
SLC	standby liquid control
SOER	significant operating experience report
SRM	source range monitor
SRM	staff requirements memorandum
SRP-LR	standard review plan for license renewal
SS	stainless steel
SSC	systems, structures, and components
TGSCC	transgranular stress corrosion cracking
TLAA	time-limited aging analysis

ABBREVIATIONS (continued)

UCS	Union of Concerned Scientists
UHS	ultimate heat sink
USI	unresolved safety issue
UT	ultrasonic testing
UV	ultraviolet

INTRODUCTION

The GALL report, Volume 2 contains 11 chapters and an appendix. The majority of the chapters contain summary descriptions and tabulations of evaluations of aging management programs for a large number of structures and components in the various major plant systems in the light-water reactor nuclear power plants. The major plant systems include the containment structures (Chapter II), structures and component supports (Chapter III), reactor vessel, internals and reactor coolant system (Chapter IV), engineered safety features (Chapter V), electrical components (Chapter VI), auxiliary systems (Chapter VII), and steam and power conversion system (Chapter VIII).

Also in Volume 2 of the GALL report, Chapter I addresses the application of the ASME Code for license renewal. Chapter IX is not used. Chapter X contains the time-limited aging analysis evaluation of aging management programs under 10 CFR 54.21(c)(1)(iii). Chapter XI contains the aging management programs for the structures and mechanical and electrical components. The Appendix of Volume 2 of the GALL report addresses quality assurance (QA) for aging management programs.

The evaluation process for the aging management programs and the application of the GALL report is described in the Summary, Volume 1, of the GALL report.

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CHAPTER I

APPLICATION OF THE ASME CODE

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APPLICATION OF THE ASME CODE

The American Society of Mechanical Engineers (ASME) codes were developed and are revised periodically by industry code committees composed of representatives of utilities, reactor designers, architect-engineers, component manufacturers, insurance companies, the U.S. Nuclear Regulatory Commission (NRC), and others. In 1971, NRC incorporated the ASME Boiler and Pressure Vessel Code into the regulations in 10 CFR 50.55a. [36 FR 11,423 (June 12, 1971)].

> The Statements of Consideration (SOC) for the final rule state:
>
> "It has been generally recognized that, for boiling and pressurized water-cooled reactors, pressure vessels, piping, pumps, and valves which are part of the reactor coolant pressure boundary should, as a minimum, be designed, fabricated, inspected, and tested in accordance with the requirements of the applicable American Society of Mechanical Engineers (ASME) codes in effect at the time the equipment is purchased[.]"
>
> The SOC also states:
>
> "Because of the safety significance of uniform early compliance by the nuclear industry with the requirements of these ASME . . . codes and published code revisions, the Commission has adopted the following amendments to Part 50 and 115, which require that certain components and systems of water-cooled reactors important to safety comply with these codes and appropriate revisions to the codes at the earliest feasible time."
>
> In addition, the SOC states:
>
> "Compliance with the provisions of the amendments and the referenced codes is intended to insure a basic, sound quality level."

The ASME code, based on the collective engineering judgment of the code committees, documents the conditions that must be monitored, the inspection techniques adequate to observe those conditions, the frequency of the inspections, and the acceptance criteria that the results of the inspections must meet in order to assure the integrity of the structures and components considered in the code. The NRC has adopted this engineering judgment with respect to selected portion of the ASME code, as incorporated in 10 CFR 50.55a.

The NRC has amended 10 CFR 50.55a periodically to incorporate later editions of the ASME code into the regulations, with modifications and limitations, as appropriate. The latest such amendment was in 1999 [64 FR 51,370 (September 22, 1999)]. In 1996, the NRC also incorporated Subsections IWE and IWL of Section XI of the ASME code into the regulations for containment inservice inspection, after evaluating these code requirements and concluding that they are effective in managing aging degradation of the containment structures [61 FR 41,303 (August 8, 1996)].

For the purpose of license renewal, the staff has extensively evaluated the appropriate ASME Section XI programs based on the ten program elements described in Volume 1 of this report. Except where noted, the staff has determined that the ASME Section XI programs provide processes for identifying degradation that is attributable to applicable aging effects and are

therefore acceptable for managing the effects of aging during the period of extended operation. Where warranted, NRC indicates that certain parts of the code programs should be augmented to satisfy aging management requirements for license renewal. When future editions of the ASME code are incorporated into NRC regulations through rulemakings to amend 10 CFR 50.55a, NRC will, as part of that process, perform an evaluation of these later editions of the ASME code for their adequacy for license renewal by using the 10 elements for program evaluation described in Volume 1 of this report.

CHAPTER II

CONTAINMENT STRUCTURES

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CONTAINMENT STRUCTURES

A. Pressurized Water Reactor (PWR) Containments

B. Boiling Water Reactor (BWR) Containments

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PWR CONTAINMENTS

A1. Concrete Containments (Reinforced and Prestressed)

A2. Steel Containments

A3. Common Components

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A1. CONCRETE CONTAINMENTS (REINFORCED AND PRESTRESSED)

A1.1 Concrete Elements

A1.2 Steel Elements

A1.3 Prestressing System

A1. CONCRETE CONTAINMENTS (REINFORCED AND PRESTRESSED)

Systems, Structures, and Components

This section addresses the elements of PWR concrete containment structures. Concrete containment structures are divided into three elements: concrete, steel, and prestressing system.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and containment spray system (V.A). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B1) and feedwater system (VIII.D1), or is supported by the containment structure, such as the polar crane (VII.B). The containment structure basemat typically provides support to the NSSS components and containment internal structures.

II Containment Structures
A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-a	Concrete elements: Dome; wall; basemat; ring girder; buttresses	Concrete	Outside containment	Loss of material (spalling, scaling) and cracking / Freeze-thaw	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, freeze-thaw does not cause loss of material from reinforced concrete in foundations, and in above and below grade exterior concrete, for plants located in a geographic region of negligible weathering conditions (weathering index <100 day-inch/yr). Loss of material from such concrete is not significant at plants located in areas in which weathering conditions are severe (weathering index >500 day-inch/yr) or moderate (100-500 day-inch/yr), provided that the concrete mix design meets the air content (entrained air 3-6%) and water-to-cement ratio (0.35-0.45) specified in ACI 318-63 (or later edition) or ACI 349-85 (or later edition). The weathering index is defined in ASTM C33-90, Table 3, Footnote E. Fig. 1 of ASTM C33-90 illustrates the various weathering index regions throughout the U.S.	No
A1.1-b	Concrete elements: Dome; wall; basemat; ring girder; buttresses	Concrete	Outside containment	Increase in porosity, permeability / Leaching of calcium hydroxide	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: Leaching of calcium hydroxide from reinforced concrete becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is	Yes, if leaching of calcium hydroxide is signifi-cant for inaccess-ible areas

II Containment Structures
A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well-cured, has low permeability, and that cracking is well controlled. Cracking is controlled through proper arrangement and distribution of reinforcing bars. All of the above characteristics are assured if the concrete was constructed with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of leaching of calcium hydroxide. Inaccessible Areas: For below-grade inaccessible areas (basemat and concrete wall), a plant-specific aging management program is required only if the above conditions are not satisfied.	
A1.1-c	Concrete elements: Dome; wall; basemat; ring girder; buttresses	Concrete	Inside or outside containment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For interior and above-grade exterior reinforced concrete, aggressive chemical attack is not significant if the concrete is not exposed to an aggressive environment (pH < 5.5), or to chloride or sulfate solutions beyond defined limits (> 500 ppm chloride, or > 1,500 ppm sulfate). Inspections performed in accordance with IWL will	Yes, if aggressive chemical attack is significant for inaccess-ible areas

II Containment Structures
A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) indicate the absence or presence of aggressive chemical attack. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
A1.1-d	Concrete elements: Dome; wall; basemat; ring girders; buttresses	Concrete	Inside or outside containment	Cracking due to expansion / Reaction with aggregates	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, investigations, tests, and petrographic examinations of aggregates performed in accordance with ASTM C295-54 or ASTM C227-50 can demonstrate that those aggregates do not react within reinforced concrete. For potentially	No

II Containment Structures

A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) reactive aggregates, aggregate-reinforced concrete reaction is not significant if the concrete was constructed in accordance with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of surface degradation due to reaction with aggregates.	
A1.1-e	Concrete elements: Dome; wall; basemat; ring girders; buttresses; reinforcing steel	Concrete; carbon steel	Inside or outside containment	Cracking, loss of bond, and loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For exterior above-grade and interior embedded steel, corrosion is not significant if the steel is not exposed to an aggressive environment (concrete pH < 11.5 or chlorides > 500 ppm). Alternatively, if the environment surrounding the concrete is not aggressive (pH > 5.5, chlorides < 500 ppm, sulfates < 1,500 ppm), corrosion of embedded steel is not significant. If such steel is exposed to an aggressive environment, corrosion is not significant if the concrete in which the steel is embedded has a low water-to-cement ratio (0.35-0.45), adequate air entrainment (3-6%), low permeability, and is designed in accordance with ACI 318-63 (or later edition) or ACI 349-85 (or later edition). Inspections performed in accordance with IWL will indicate the absence or presence of visible corrosion	Yes, if corrosion of embedded steel is significant for inaccess-ible areas

II Containment Structures
A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) of embedded steel. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of representative samples of below-grade concrete, when excavated for any reason, is to be included as part of a plant-specific program. If the below-grade environment is not aggressive, this aging effect is not significant. Periodic monitoring of below-grade water chemistry (including consideration of potential seasonal variations) is an acceptable approach to demonstrate that the below-grade environment is not aggressive.	
A1.1-f	Concrete elements: Dome; wall; basemat; ring girder; buttresses	Concrete	Inside or outside containment	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S6, "Structures Monitoring Program" The initial licensing basis for some plants included a program to monitor settlement. If no settlement was evident during the first decade or so, the NRC may have given the licensee approval to discontinue the program. However, if a de-watering system is relied upon for control of settlement, then the licensee	No, if within the scope of the applicant's structures monitoring program

II Containment Structures

A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) is to ensure proper functioning of the de-watering system through the period of extended operation.	
A1.1-g	Concrete elements: Foundation; subfoundation	Concrete; porous concrete	Flowing water under foundation	Reduction in foundation strength, cracking, differential settlement / Erosion of porous concrete subfoundation	Chapter XI.S6, "Structures Monitoring Program" Erosion of cement from porous concrete subfoundations beneath containment basemats is described in IN 97-11. IN 98-26 proposes Maintenance Rule Structures Monitoring for managing this aging effect, if applicable. If a de-watering system is relied upon for control of erosion of cement from porous concrete subfoundations, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program
A1.1-h	Concrete elements: Dome; wall; basemat; ring girder; buttresses	Concrete	Inside or outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program The implementation of 10 CFR 50.55a and IWL would not be able to identify the reduction of strength and modulus due to elevated temperature. Thus, for any portions of concrete containment that exceed specified temperature limits, further evaluations are warranted. Subsection CC-3400 of ASME Section III, Division 2, specifies the concrete temperature limits for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as	Yes, if applicable.

II Containment Structures
A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) around penetrations, which are not allowed to exceed 200°F. If significant equipment loads are supported by concrete at temperatures exceeding 150°F, an evaluation of the ability to withstand the postulated design loads is to be made. Higher temperatures than given above may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and this reduction is applied to the design allowables.	
A1.2-a	Steel elements: Liner; liner anchors; integral attachments	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures

A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required. Chapter XI.S4, "10 CFR Part 50, Appendix J" and If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program."	No No
A1.3-a	Prestressing system: Tendons; anchorage components	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S2, "ASME Section XI, Subsection IWL"	No

II Containment Structures

A1. PWR Concrete Containments (Reinforced and Prestressed)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.3-b	Prestressing system: Tendons; anchorage components	Carbon steel	Inside or outside containment	Loss of prestress / Relaxation; shrinkage; creep; elevated temperature	Loss of tendon prestress is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.5, "Concrete Containment Tendon Prestress" for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii). See Chapter X.S1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii). For periodic monitoring of prestress, see Chapter XI.S2.	Yes, TLAA

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A2. STEEL CONTAINMENTS

A2.1 Steel Elements

A2.2 Concrete Elements

A2. STEEL CONTAINMENTS

Systems, Structures, and Components

This section addresses the elements of PWR steel containment structures. Steel containment structures are divided into two elements: steel and concrete.

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and containment spray system (V.A). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B1) and feedwater system (VIII.D1), or is supported by the containment structure, such as the polar crane (VII.B). The containment structure basemat typically provides support to the NSSS components and containment internal structures.

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.1-a	Steel elements: Dome; wall; embedded floor	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE" For inaccessible areas (embedded containment steel shell or liner), loss of material due to corrosion is not significant if the following conditions are satisfied: 1. Concrete meeting the requirements of ACI 318 or 349 and the guidance of 201.2R was used for the containment concrete in contact with the embedded containment shell or liner. 2. The concrete is monitored to ensure that it is free of penetrating cracks that provide a path for water seepage to the surface of the containment shell or liner. 3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with IWE requirements. 4. Borated water spills and water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner. If any of the above conditions cannot be satisfied, then a plant-specific aging management program for corrosion is required.	Yes, if corrosion is significant for inaccess-ible areas

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) Chapter XI.S4, "10 CFR Part 50, Appendix J" and If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No
A2.2-a	Concrete elements: Basemat	Concrete	Outside containment	Loss of material (spalling, scaling) and cracking /Freeze-thaw	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, freeze-thaw does not cause loss of material from reinforced concrete in foundations, and in above and below grade exterior concrete, for plants located in a geographic region of negligible weathering conditions (weathering index <100 day-inch/yr). Loss of material from such concrete is not significant at plants located in areas in which weathering conditions are severe (weathering index >500 day-inch/yr) or moderate (100-500 day-inch/yr), provided that the concrete mix design meets the air content (entrained air 3-6%) and water-to-cement ratio (0.35-0.45) specified in ACI 318-63 (or later edition) or ACI 349-85 (or later edition).	No

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) 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.	
A2.2-b	Concrete elements: Basemat	Concrete	Outside containment	Increase in porosity, permeability / Leaching of calcium hydroxide	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: Leaching of calcium hydroxide from reinforced concrete becomes significant only if the concrete is exposed to flowing water. Even if reinforced concrete is exposed to flowing water, such leaching is not significant if the concrete is constructed to ensure that it is dense, well-cured, has low permeability, and that cracking is well controlled. Cracking is controlled through proper arrangement and distribution of reinforcing bars. All of the above characteristics are assured if the concrete was constructed with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of leaching of calcium hydroxide. Inaccessible Areas: For below grade inaccessible areas (basemat and concrete wall), a plant-specific aging management program is required only if the above conditions are not satisfied.	Yes, if leaching of calcium hydroxide is significant for inaccess-ible areas

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.2-c	Concrete elements: Basemat	Concrete	Inside or outside containment	Increase in porosity and permeability, cracking, loss of material (spalling, scaling) / Aggressive chemical attack	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For interior and above-grade exterior reinforced concrete, aggressive chemical attack is not significant if the concrete is not exposed to an aggressive environment (pH < 5.5), or to chloride or sulfate solutions beyond defined limits (> 500 ppm chloride, or > 1,500 ppm sulfate). Inspections performed in accordance with IWL will indicate the absence or presence of aggressive chemical attack. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of 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	Yes, if aggressive chemical attack is significant for inaccess-ible areas

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) demonstrate that the below-grade environment is not aggressive.	
A2.2-d	Concrete elements: Basemat	Concrete	Inside or outside containment	Cracking due to expansion / Reaction with aggregates	Chapter XI.S2, "ASME Section XI, Subsection IWL" As described in NUREG-1557, investigations, tests, and petrographic examinations of aggregates performed in accordance with ASTM C295-54 or ASTM C227-50 can demonstrate that those aggregates do not react within reinforced concrete. For potentially reactive aggregates, aggregate-reinforced concrete reaction is not significant if the concrete was constructed in accordance with the guidance of ACI 201.2R-77. Inspections performed in accordance with IWL will indicate the absence or presence of surface degradation due to reaction with aggregates.	No
A2.2-e	Concrete elements: Basemat and reinforcing steel	Concrete; carbon steel	Inside or outside containment	Cracking, loss of bond, and loss of material (spalling, scaling) / Corrosion of embedded steel	Chapter XI.S2, "ASME Section XI, Subsection IWL" Accessible Areas: For exterior above-grade and interior embedded steel, corrosion is not significant if the steel is not exposed to an aggressive environment (concrete pH < 11.5 or chlorides > 500 ppm). Alternatively, if the environment surrounding the concrete is non-aggressive (pH > 5.5, chlorides < 500 ppm,	Yes, if corrosion of embedded steel is significant for inaccess-ible areas

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) sulfates < 1,500 ppm), corrosion of embedded steel is not significant. If such steel is exposed to an aggressive environment, corrosion is not significant if the concrete in which the steel is embedded has a low water-to-cement ratio (0.35-0.45), adequate air entrainment (3-6%), low permeability, and is designed in accordance with ACI 318-63 (or later edition) or ACI 349-85 (or later edition). Inspections performed in accordance with IWL will indicate the absence or presence of visible corrosion of embedded steel. Inaccessible Areas: For below-grade exterior reinforced concrete (basemat, embedded walls), a plant-specific aging management program is required only if the below-grade environment is aggressive (pH < 5.5, chlorides > 500 ppm, or sulfates > 1,500 ppm). Examination of 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	

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
					(continued) demonstrate that the below-grade environment is not aggressive.	
A2.2-f	Concrete elements: Basemat	Concrete	Inside or outside containment	Cracks; distortion; increase in component stress level / Settlement	Chapter XI.S6, "Structures Monitoring Program" The initial Licensing Basis for some plants included a program to monitor settlement. If no settlement was evident during the first decade or so, the NRC may have given the licensee approval to discontinue the program. However, if a de-watering system is relied upon for control of settlement, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program
A2.2-g	Concrete elements: Foundation; subfoundation	Concrete; porous concrete	Flowing water under foundation	Reduction in foundation strength, cracking, differential settlement / Erosion of porous concrete subfoundation	Chapter XI.S6, "Structures Monitoring Program" Erosion of cement from porous concrete subfoundations beneath containment basemats is described in IN 97-11. IN 98-26 proposes Maintenance Rule Structures Monitoring for managing this aging effect, if applicable. If a de-watering system is relied upon for control of erosion of cement from porous concrete subfoundations, then the licensee is to ensure proper functioning of the de-watering system through the period of extended operation.	No, if within the scope of the applicant's structures monitoring program

II Containment Structures
A2. PWR Steel Containments

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A2.2-h	Concrete elements: Basemat	Concrete	Inside or outside containment	Reduction of strength and modulus / Elevated temperature (>150°F general; >200°F local)	Plant-specific aging management program The implementation of 10 CFR 50.55a and IWL would not be able to identify the reduction of strength and modulus due to elevated temperature. Thus, for any portions of concrete containment that exceed specified temperature limits, further evaluations are warranted. Subsection CC-3400 of ASME Section III, Division 2, specifies the concrete temperature limits for normal operation or any other long-term period. The temperatures shall not exceed 150°F except for local areas, such as around penetrations, which are not allowed to exceed 200°F. If significant equipment loads are supported by concrete at temperatures exceeding 150°F, an evaluation of the ability to withstand the postulated design loads is to be made. Higher temperatures than given above may be allowed in the concrete if tests and/or calculations are provided to evaluate the reduction in strength and this reduction is applied to the design allowables.	Yes, if applicable

A3. COMMON COMPONENTS

A3.1 Penetration Sleeves, Penetration Bellows, Dissimilar Metal Welds

A3.2 Personnel Airlock, Equipment Hatch

A3.3 Seals, Gaskets, and Moisture Barriers (Caulking, Flashing, and Other Sealants)

A3. COMMON COMPONENTS

Systems, Structures, and Components

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

System Interfaces

Functional interfaces include the primary containment heating and ventilation system (VII.F3), containment isolation system (V.C), and containment spray system (V.A). Physical interfaces exist with any structure, system, or component that either penetrates the containment wall, such as the main steam system (VIII.B1) and feedwater system (VIII.D1), or is supported by the containment structure, such as the polar crane (VII.B). The containment structure basemat typically provides support to the NSSS components and containment internal structures.

II Containment Structures
A3. PWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-a	Penetration sleeves	Carbon steel; dissimilar metal welds	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE," (Note: IWE examination category E-F, surface examination of dissimilar metal welds, is optional) Chapter XI.S4, "10 CFR Part 50, Appendix J," and If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program"	No No No
A3.1-b	Penetration sleeves; penetration bellows	Carbon Steel; stainless steel; dissimilar metal welds	Inside or outside containment	Cumulative fatigue damage / Fatigue (Only if CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.6, "Containment Liner Plate and Penetration Fatigue Analysis" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA
A3.1-c	Penetration sleeves; penetration bellows	Carbon steel; stainless steel; dissimilar metal welds	Inside or outside containment	Cracking / Cyclic loading (CLB fatigue analysis does not exist)	Chapter XI.S1 "ASME Section XI, Subsection IWE " and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* VT-3 visual inspection may not detect fine cracks.	Yes, detection of aging effects is to be evaluated

II Containment Structures
A3. PWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.1-d	Penetration sleeves; penetration bellows	Stainless steel; dissimilar metal welds	Inside or outside containment	Crack initiation and growth / Stress corrosion cracking	Chapter XI.S1, "ASME Section XI, Subsection IWE" and Chapter XI.S4, "10 CFR Part 50, Appendix J" Evaluation of 10 CFR 50.55a/IWE is augmented as follows: *(4) Detection of Aging Effects:* Stress corrosion cracking (SCC) is a concern for dissimilar metal welds. In the case of bellows assemblies, SCC may cause aging effects particularly if the material is not shielded from a corrosive environment. Subsection IWE covers inspection of these items under examination categories E-B, E-F, and E-P (10 CFR Part 50, Appendix J pressure tests). 10 CFR 50.55a identifies examination categories E-B and E-F as optional during the current term of operation. For the extended period of operation, Examination Categories E-B & E-F, and additional appropriate examinations to detect SCC in bellows assemblies and dissimilar metal welds are warranted to address this issue. *(10) Operating Experience:* IN 92-20 describes an instance of containment bellows cracking, resulting in loss of leak tightness.	Yes, detection of aging effects is to be evaluated

II Containment Structures
A3. PWR Containment Common Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A3.2-a	Personnel airlock; equipment hatch	Carbon steel	Inside or outside containment	Loss of material / Corrosion	Chapter XI.S1, "ASME Section XI, Subsection IWE," Chapter XI.S4, "10 CFR Part 50, Appendix J," and If a coatings program is credited for managing loss of material due to corrosion during the current licensing term (e.g., relief request from IWE), then it is to be continued during the period of extended operation. See Chapter XI.S8, "Protective Coating Monitoring and Maintenance Program."	No No No
A3.2-b	Personnel airlock; equipment hatch: Locks, hinges, and closure mechanisms	Carbon Steel	Inside or outside containment	Loss of leak tightness in closed position / Mechanical wear of locks, hinges and closure mechanisms	Chapter XI.S4, "10 CFR Part 50, Appendix J" and Plant Technical Specifications	No
A3.3-a	Seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Various	Inside or outside containment	Loss of sealing; leakage through containment / Deterioration of seals, gaskets, and moisture barriers (caulking, flashing, and other sealants)	Chapter XI.S1, "ASME Section XI, Subsection IWE" Leak tightness will be monitored by 10 CFR Part 50, Appendix J Leak Rate Tests for pressure boundary, seals and gaskets (including O-rings).	No

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BWR CONTAINMENTS

B1. Mark I Containments

B2. Mark II Containments

B3. Mark III Containments

B4. Common Components

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B1. MARK I CONTAINMENTS

B1.1 Steel Containments

B1.1.1 Steel Elements

B1. MARK I CONTAINMENTS

Systems, Structures, and Components

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

System Interfaces

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

II Containment Structures
B1.1 BWR Mark I Steel Containments

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

II **Containment Structures**
B1.1 BWR Mark I Steel Containments

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

II Containment Structures
B1.1 BWR Mark I Steel Containments

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

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B2. MARK II CONTAINMENTS

B2.1 Steel Containments

B2.1.1 Steel Elements

B2.2 Concrete Containments

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

B2. MARK II CONTAINMENTS

Systems, Structures, and Components

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

System Interfaces

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

II Containment Structures
B2.1 BWR Mark II Steel Containments

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

II Containment Structures
B2.1 BWR Mark II Steel Containments

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

II Containment Structures
B2.2 BWR Mark II Concrete Containments

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

II Containment Structures
B2.2 BWR Mark II Concrete Containments

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

II Containment Structures
B2.2 BWR Mark II Concrete Containments

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

II Containment Structures
B2.2 BWR Mark II Concrete Containments

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

II **Containment Structures**
B2.2 BWR Mark II Concrete Containments

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

II **Containment Structures**
B2.2 BWR Mark II Concrete Containments

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

II **Containment Structures**
B2.2 BWR Mark II Concrete Containments

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

II Containment Structures
B2.2 BWR Mark II Concrete Containments

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

II **Containment Structures**
B2.2 BWR Mark II Concrete Containments

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

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B3. MARK III CONTAINMENTS

B3.1 Steel Containments

B3.1.1 Steel Elements
B3.1.2 Concrete Elements

B3.2 Concrete Containments

B3.2.1 Concrete Elements
B3.2.2 Steel Elements

B3. MARK III CONTAINMENTS

Systems, Structures, and Components

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

System Interfaces

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

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

II Containment Structures
B3.1 BWR Mark III Steel Containments

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

II **Containment Structures**
B3.2 BWR Mark III Concrete Containments

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

II Containment Structures
B3.2 BWR Mark III Concrete Containments

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

B4. COMMON COMPONENTS

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

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

B4.3 Seals, Gaskets, and Moisture Barriers

B4. COMMON COMPONENTS

Systems, Structures, and Components

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

System Interfaces

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

II Containment Structures
B4 BWR Containment Common Components

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

II Containment Structures
B4 BWR Containment Common Components

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

II **Containment Structures**
B4 BWR Containment Common Components

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

II **Containment Structures**
B4 BWR Containment Common Components

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

CHAPTER III

STRUCTURES AND COMPONENT SUPPORTS

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Chapter III A: Class 1 Structures

Chapter III B: Component Supports

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CLASS 1 STRUCTURES

A1. Group 1 Structures (BWR Reactor Bldg., PWR Shield Bldg., Control Rm./Bldg.)

A2. Group 2 Structures (BWR Reactor Bldg. with Steel Superstructure)

A3. Group 3 Structures (Auxiliary Bldg., Diesel Generator Bldg., Radwaste Bldg., Turbine Bldg., Switchgear Rm., AFW Pumphouse, Utility/Piping Tunnels)

A4. Group 4 Structures (Containment Internal Structures, excluding Refueling Canal)

A5. Group 5 Structures (Fuel Storage Facility, Refueling Canal)

A6. Group 6 Structures (Water-Control Structures)

A7. Group 7 Structures (Concrete Tanks)

A8. Group 8 Structures (Steel Tanks)

A9. Group 9 Structures (BWR Unit Vent Stack)

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

A1.1 Concrete Elements

A1.2 Steel Elements

A1.3 Masonry Walls

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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. with Steel Superstructure)

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

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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COMPONENT SUPPORTS

B1. Supports for ASME Piping and Components

B2. Supports for Cable Trays, Conduit, HVAC Ducts, TubeTrack, Instrument Tubing, Non-ASME Piping and Components

B3. Anchorage of Racks, Panels, Cabinets, and Enclosures for Electrical Equipment and Instrumentation

B4. Supports for Emergency Diesel Generator (EDG), HVAC System Components, and Other Miscellaneous Mechanical Equipment

B5. Supports for Platforms, Pipe Whip Restraints, Jet Impingement Shields, Masonry Walls, and Other Miscellaneous Structures

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B1. SUPPORTS FOR ASME PIPING AND COMPONENTS

B1.1 Class 1

- B1.1.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure
- B1.1.2 High Strength Bolting for NSSS Component Supports
- B1.1.3 Constant/Variable Load Spring Hangers; Guides; Stops; Sliding Surfaces; Design Clearances; Vibration Isolators
- B1.1.4 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B1.2 Class 2 and 3

- B1.2.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure
- B1.2.2 Constant/Variable Load Spring Hangers; Guides; Stops; Sliding Surfaces; Design Clearances; Vibration Isolators
- B1.2.3 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B1.3 Class MC (BWR Containment Supports)

- B1.3.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure
- B1.3.2 Guides; Stops; Sliding Surfaces; Design Clearances
- B1.3.3 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B1. SUPPORTS FOR ASME PIPING AND COMPONENTS

Systems, Structures, and Components

This section addresses supports and anchorage for ASME piping systems and components. It is subdivided into Class 1 (III.B1.1), Class 2 and 3 (III.B1.2), and Class MC (III.B1.3). Applicable aging effects are identified and the aging management review is presented for each applicable combination of support component and aging effect.

System Interfaces

Physical interfaces exist with the structure, system or component being supported and with the building structural element to which the support is anchored. A primary function of supports is to provide anchorage of the supported element for internal and external design basis events, so that the supported element can perform its intended function.

III. Structures and Components Supports

B1.1 Supports for ASME Class 1 Piping and Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.1.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside containment	Loss of material / Environmental corrosion (i.e., pitting corrosion, general corrosion, etc.)	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.1.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B1.1.1-c	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside containment	Cumulative fatigue damage / Fatigue (only if a CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
B1.1.2-a	High strength bolting for NSSS component supports	Low alloy steel, yield strength >150 ksi	Inside containment	Cracking / Stress corrosion cracking	Chapter XI.M18, "Bolting Integrity"	No

III. Structures and Components Supports

B1.1 Supports for ASME Class 1 Piping and Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.1.3-a	Constant and variable load spring hangers; guides; stops; sliding surfaces; design clearances; vibration isolators	Steel and non-steel materials (e.g., lubrite plates, vibration isolators, etc.)	Inside containment	Loss of mechanical function / Corrosion, distortion, dirt, overload, fatigue due to vibratory and cyclic thermal loads; elastomer hardening	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.1.4-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout	Inside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

III. Structures and Components Supports

B1.2 Supports for ASME Class 2 and 3 Piping and Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.2.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e. pitting corrosion, general corrosion)	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.2.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B1.2.1-c	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Cumulative fatigue damage / Fatigue (only if a CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
B1.2.2-a	Constant and variable load spring hangers; guides; stops; sliding surfaces; design clearances; vibration isolators	Steel and non-steel materials (e.g., lubrite plates, vibration isolators, etc.)	Inside or outside containment	Loss of mechanical function / Corrosion, distortion, dirt, overload, fatigue due to vibratory and cyclic thermal loads; elastomer hardening	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.2.3-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout	Inside or outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

III. Structures and Components Supports

B1.3 Supports for ASME Class MC Components (BWR downcomer bracing; torus seismic restraints; torus support saddles/columns; vent system supports)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B1.3.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e. pitting corrosion, general corrosion, etc.)	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.3.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Cumulative fatigue damage / Fatigue (only if a CLB fatigue analysis exists)	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3, "Metal Fatigue" for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA
B1.3.2-a	Guides; stops; sliding surfaces; design clearances	Steel and non-steel materials (e.g., lubrite plates, etc.)	Inside or outside containment	Loss of mechanical function / Corrosion, distortion, dirt, overload, fatigue due to vibratory and cyclic thermal loads; elastomer hardening	Chapter XI.S3, "ASME Section XI, Subsection IWF"	No
B1.3.3-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout	Inside or outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

B2. SUPPORTS FOR CABLE TRAYS, CONDUIT, HVAC DUCTS, TUBETRACK, INSTRUMENT TUBING, NON-ASME PIPING AND COMPONENTS

B2.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure

B2.2 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B2. SUPPORTS FOR CABLE TRAYS, CONDUIT, HVAC DUCTS, TUBETRACK, INSTRUMENT TUBING, NON-ASME PIPING AND COMPONENTS

Systems, Structures, and Components

This section addresses supports and anchorage for cable trays, conduit, HVAC ducts, tube track, instrument tubing, and non-ASME piping and components. Applicable aging effects are identified and the aging management review is presented for each applicable combination of support component and aging effect.

System Interfaces

Physical interfaces exist with the structure, system or component being supported and with the building structural element to which the support is anchored. A primary function of supports is to provide anchorage of the supported element for internal and external design basis events, so that the supported element can perform its intended function.

III. Structures and Component Supports

B2 Supports for Cable Trays, Conduit, HVAC Ducts, Tube Track, Instrument Tubing, Non-ASME Piping and Components

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B2.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e., pitting corrosion, general corrosion, etc.)	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program
B2.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B2.2-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout; masonry	Inside or outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

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B3. ANCHORAGE OF RACKS, PANELS, CABINETS, AND ENCLOSURES FOR ELECTRICAL EQUIPMENT AND INSTRUMENTATION

B3.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure

B3.2 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B3. ANCHORAGE OF RACKS, PANELS, CABINETS, AND ENCLOSURES FOR ELECTRICAL EQUIPMENT AND INSTRUMENTATION

Systems, Structures, and Components

This section addresses supports and anchorage for racks, panels, cabinets, and enclosures for electrical equipment and instrumentation Applicable aging effects are identified and the aging management review is presented for each applicable combination of support component and aging effect.

System Interfaces

Physical interfaces exist with the structure, system or component being supported and with the building structural element to which the support is anchored. A primary function of supports is to provide anchorage of the supported element for internal and external design basis events, so that the supported element can perform its intended function.

III. Structures and Component Supports

B3 Anchorage of Racks, Panels, Cabinets, and Enclosures for Electrical Equipment and Instrumentation

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B3.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e., pitting corrosion, general corrosion, etc.)	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program
B3.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B3.2-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout; masonry	Inside or outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

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B4. SUPPORTS FOR EMERGENCY DIESEL GENERATOR (EDG), HVAC SYSTEM COMPONENTS, AND OTHER MISCELLANEOUS MECHANICAL EQUIPMENT

B4.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure

B4.2 Vibration Isolation Elements

B4.3 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B4. SUPPORTS FOR EMERGENCY DIESEL GENERATOR (EDG), HVAC SYSTEM COMPONENTS, AND OTHER MISCELLANEOUS MECHANICAL EQUIPMENT

Systems, Structures, and Components

This section addresses supports and anchorage for miscellaneous mechanical equipment. Applicable aging effects are identified and the aging management review is presented for each applicable combination of support component and aging effect.

System Interfaces

Physical interfaces exist with the structure, system or component being supported and with the building structural element to which the support is anchored. A primary function of supports is to provide anchorage of the supported element for internal and external design basis events, so that the supported element can perform its intended function.

III. Structures and Components Supports

B4 Supports for Emergency Diesel Generator (EDG), HVAC System Components, and Other Miscellaneous Mechanical Equipment

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B4.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e., pitting corrosion, general corrosion, etc.)	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's Structures Monitoring Program
B4.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B4.2-a	Vibration isolation elements	Non-metallic (e.g., Rubber)	Inside or outside containment	Reduction or loss of isolation function / Radiation hardening, temperature, humidity, sustained vibratory loading	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program
B4.3-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout	Inside or outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

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B5. SUPPORTS FOR PLATFORMS, PIPE WHIP RESTRAINTS, JET IMPINGEMENT SHIELDS, MASONRY WALLS, AND OTHER MISCELLANEOUS STRUCTURES

B5.1 Support Members; Welds; Bolted Connections; Support Anchorage to Building Structure

B5.2 Building Concrete at Locations of Expansion and Grouted Anchors; Grout Pads for Support Base Plates

B5. SUPPORTS FOR PLATFORMS, PIPE WHIP RESTRAINTS, JET IMPINGEMENT SHIELDS, MASONRY WALLS, AND OTHER MISCELLANEOUS STRUCTURES

Systems, Structures, and Components

This section addresses supports and anchorage for miscellaneous structures. Applicable aging effects are identified and the aging management review is presented for each applicable combination of support component and aging effect.

System Interfaces

Physical interfaces exist with the structure, system or component being supported and with the building structural element to which the support is anchored. A primary function of supports is to provide anchorage of the supported element for internal and external design basis events, so that the supported element can perform its intended function.

III. Structures and Components Supports

B5 Supports for Platforms, Pipe Whip Restraints, Jet Impingement Shields, Masonry Walls, and Other Miscellaneous Structures

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
B5.1-a	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside or outside containment	Loss of material / Environmental corrosion (i.e., pitting corrosion, general corrosion, etc.)	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program
B5.1-b	Support members; welds; bolted connections; support anchorage to building structure	Carbon steel	Inside PWR containment	Loss of material / Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"	No
B5.2-a	Building concrete at locations of expansion and grouted anchors; grout pads for support base plates	Reinforced concrete; grout	Inside or Outside containment	Reduction in concrete anchor capacity due to local concrete degradation / Service-induced cracking or other concrete aging mechanisms	Chapter XI.S6, "Structures Monitoring Program"	No, if within the scope of the applicant's structures monitoring program

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CHAPTER IV

REACTOR VESSEL, INTERNALS, AND REACTOR COOLANT SYSTEM

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MAJOR PLANT SECTIONS

A1. Reactor Vessel (Boiling Water Reactor)

A2. Reactor Vessel (Pressurized Water Reactor)

B1. Reactor Vessel Internals (Boiling Water Reactor)

B2. Reactor Vessel Internals (PWR) - Westinghouse

B3. Reactor Vessel Internals (PWR) - Combustion Engineering

B4. Reactor Vessel Internals (PWR) - Babcock and Wilcox

C1. Reactor Coolant Pressure Boundary (Boiling Water Reactor)

C2. Reactor Coolant System and Connected Lines (Pressurized Water Reactor)

D1. Steam Generator (Recirculating)

D2. Steam Generator (Once-Through)

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A1. REACTOR VESSEL (BOILING WATER REACTOR)

A1.1 Top Head Enclosure

- A1.1.1 Top Head
- A1.1.2 Nozzles (Vent, Top Head Spray or Reactor Core Isolation Cooling [RCIC], and Spare)
- A1.1.3 Head Flange
- A1.1.4 Closure Studs and Nuts
- A1.1.5 Vessel Flange Leak Detection Line

A1.2 Vessel Shell

- A1.2.1 Vessel Flange
- A1.2.2 Upper Shell
- A1.2.3 Intermediate Nozzle Shell
- A1.2.4 Intermediate Beltline Shell
- A1.2.5 Lower Shell
- A1.2.6 Beltline Welds
- A1.2.7 Attachment Welds

A1.3 Nozzles

- A1.3.1 Main Steam
- A1.3.2 Feedwater
- A1.3.3 Control Rod Drive (CRD) Return Line
- A1.3.4 Low Pressure Coolant Injection (LPCI) or Residual Heat Removal (RHR) Injection Mode

A1.4 Nozzles Safe Ends

- A1.4.1 High Pressure Core Spray (HPCS)
- A1.4.2 Low Pressure Core Spray (LPCS)
- A1.4.3 CRD Return Line
- A1.4.4 Recirculating Water (Inlet and Outlet)
- A1.4.5 LPCI or RHR Injection Mode

A1.5 Penetrations

- A1.5.1 CRD Stub Tubes
- A1.5.2 Instrumentation
- A1.5.3 Jet Pump Instrument
- A1.5.4 Standby Liquid Control
- A1.5.5 Flux Monitor
- A1.5.6 Drain Line

A1.6 Bottom Head

A1.7 Support Skirt and Attachment Welds

A1. REACTOR VESSEL (BOILING WATER REACTOR)

Systems, Structures, and Components

This section comprises the boiling water reactor (BWR) pressure vessel and consists of the vessel shell and flanges; attachment welds; the top and bottom heads; nozzles (including safe ends) for the reactor coolant recirculating system and connected systems such as high and low pressure core spray, high and low pressure coolant injection, main steam, and feedwater systems; penetrations for CRD stub tubes, instrumentation, standby liquid control, flux monitor, and drain lines; and control rod drive mechanism housings. The support skirt and attachment welds for vessel supports are also included in the table. Based on Regulatory Guide 1.26, "Quality Group Classifications and Standards for Water, Steam, and Radioactive-Waste-Containing Components of Nuclear Power Plants," all structures and components that comprise the reactor vessel are governed by Group A Quality Standards.

System Interfaces

The systems that interface with the reactor vessel include the reactor vessel internals (IV.B1), the reactor coolant pressure boundary (IV.C1), the emergency core cooling system (V.D2), and standby liquid control system (VII.E2).

IV **Reactor Vessel, Internals, and Reactor Coolant System**
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-a A1.1.1 A1.1.2	Top head enclosure (without cladding) Top head Nozzles (vent, top head spray or RCIC, and spare)	SA302-Gr B, SA533-Gr B, SA336	288°C (550°F) steam	Loss of material/ General, pitting, and crevice corrosion	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No
A1.1-b A1.1.3	Top head enclosure Head flange	SA302-Gr B, SA533-Gr B, SA336, with or without stainless-steel cladding	288°C (550°F) steam	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA
A1.1-c A1.1.4	Top head enclosure Closure studs and nuts	SA193-Gr. B7, SA540-Gr. B23/24, SA320-Gr. L43 (AISI 4340), SA194-Gr. 7; maximum tensile strength <1172 MPa (<170 Ksi)	Air, leaking reactor coolant water and/or steam at 288°C (550°F)	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking	Chapter XI.M3, "Reactor Head Closure Studs"	No

IV Reactor Vessel, Internals, and Reactor Coolant System
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.1-d A1.1.5	Top head enclosure Vessel flange leak detection line	Stainless steel, Ni alloys	Leaking reactor coolant water and/or steam up to 288°C (550°F)	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking	A plant-specific aging management program is to be evaluated because existing programs may not be able to mitigate or detect crack initiation and growth due to SCC of vessel flange leak detection line.	Yes, plant specific
A1.2-a A1.2.1 A1.2.2	Vessel shell Vessel flange Upper shell	SA302-Gr B, SA533-Gr B, SA336 with stainless steel cladding	288°C (550°F) steam	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA
A1.2-b A1.2.3 A1.2.4 A1.2.5 A1.2.6	Vessel shell Intermediate nozzle shell Intermediate beltline shell Lower shell Beltline welds	SA302-Gr B, SA533-Gr B with 308, 309, 308L, 309L cladding	288°C (550°F) reactor coolant water max 5×10^{9} $n/cm^2 \cdot s$	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA

IV Reactor Vessel, Internals, and Reactor Coolant System
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.2-c A1.2.4 A1.2.6	Vessel shell Intermediate beltline shell Beltline welds	SA302-Gr B, SA533-Gr B with 308, 309, 308L, 309L cladding; and low–alloy steel weldments	288°C (550°F) reactor coolant water $5x10^{8}$ - $5x10^{9}$ n/cm^{2}·s	Loss of fracture toughness/ Neutron irradiation embrittlement	Neutron irradiation embrittlement is a time dependent aging mechanism to be evaluated for the period of extended operation for all ferritic materials that have a neutron fluence exceeding 10^{17} n/cm^{2} (E >1 MeV) at the end of the license renewal term. Aspects of this evaluation may involve a TLAA. In accordance with approved BWRVIP-74, the TLAA is to evaluate the impact of neutron embrittlement on: (a) the adjusted reference temperature, the plant's pressure-temperature limits, (b) the need for inservice inspection of circumferential welds, and (c) the Charpy upper shelf energy or the equivalent margins analyses performed in accordance with 10 CFR 50, Appendix G. Additionally, the applicant is to monitor axial beltline weld embrittlement. One acceptable method is to determine that the mean RT_{NDT} of the axial beltline welds at the end of the extended period of operation is less than the value specified by the staff in its May 7, 2000 letter. See the Standard Review Plan, Section 4.2 "Reactor Vessel Neutron Embrittlement" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA

IV Reactor Vessel, Internals, and Reactor Coolant System
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.2-d A1.2.4 A1.2.6	Vessel shell Intermediate beltline shell Beltline welds	SA302-Gr B, SA533-Gr B with 308, 309, 308L, 309L cladding; and low–alloy steel weldments	288°C (550°F) reactor coolant water $5x10^8$ - $5x10^9$ $n/cm^2 \cdot s$	Loss of fracture toughness/ Neutron irradiation embrittlement	Chapter XI.M31, "Reactor Vessel Surveillance"	Yes, plant specific
A1.2-e A1.2.7	Vessel shell Attachment welds	Stainless steel, Inconel 182	288°C (550°F) reactor coolant water	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking	Chapter XI.M4, "BWR Vessel ID Attachment Welds," and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No
A1.3-a A1.3.1	Nozzles Main steam	SA508-Cl2 with or without stainless-steel cladding	288°C (550°F) steam	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA

IV **Reactor Vessel, Internals, and Reactor Coolant System**
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.3-b A1.3.2	Nozzles Feedwater	SA508-Cl2 with or without stainless steel cladding	Up to 288°C (550°F), reactor coolant water	Crack initiation and growth/ Cyclic loading	Chapter XI.M5, "BWR Feedwater Nozzle"	No
A1.3-c A1.3.3	Nozzles Control rod drive return line	SA508-Cl2 with or without stainless steel cladding	Up to 288°C (550°F), reactor coolant water	Crack initiation and growth/ Cyclic loading	Chapter XI.M6, "BWR Control Rod Drive Return Line Nozzle"	No
A1.3-d A1.3.2 A1.3.3	Nozzles Feedwater Control rod drive return line	SA508-Cl2 with or without stainless steel cladding	Up to 288°C (550°F), reactor coolant water	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA

IV Reactor Vessel, Internals, and Reactor Coolant System
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.3-e A1.3.4	Nozzles Low pressure coolant injection or RHR injection mode	SA508-Cl2	Up to 288°C reactor coolant water $5x10^8$ - $5x10^9$ $n/cm^2 \cdot s$	Loss of fracture toughness/ Neutron irradiation embrittlement	Neutron irradiation embrittlement is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation for all ferritic materials that have a neutron fluence greater than 10^{17} n/cm^2 (E >1 MeV) at the end of the license renewal term. In accordance with approved BWRVIP-74, the TLAA is to evaluate the impact of neutron embrittlement on: (a) the adjusted reference temperature, the plant's pressure-temperature limits, (b) the Charpy upper shelf energy, and (c) the equivalent margins analyses performed in accordance with 10 CFR 50, Appendix G. The applicant may choose to demonstrate that the materials of the nozzles are not controlling for the TLAA evaluations. See the Standard Review Plan, Section 4.2 "Reactor Vessel Neutron Embrittlement" for acceptable methods for meeting the requirements of 10 CFR 54.21(c).	Yes, TLAA
A1.4-a A1.4.1 A1.4.2 A1.4.3 A1.4.4 A1.4.5	Nozzle safe ends High pressure core spray Low pressure core spray Control rod drive return line Recirculating water Low pressure coolant injection or RHR injection mode	Stainless steel, SB-166 (Inconel 182 butter, and Inconel 82 or 182 weld)	Up to 288°C (550°F), reactor coolant water	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking	Chapter XI.M7, "BWR Stress Corrosion Cracking," and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No

IV Reactor Vessel, Internals, and Reactor Coolant System
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.4-b A1.4.3	Nozzle safe ends Control rod drive return line	Stainless steel, SB-166 (Inconel 182 butter, and Inconel 82 or 182 weld)	Up to 288°C (550°F), reactor coolant water	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA
A1.5-a A1.5.1 A1.5.2 A1.5.3 A1.5.4 A1.5.5 A1.5.6	Penetrations Control rod drive stub tubes Instrumentation Jet pump instrument Standby liquid control Flux monitor Drain line	Stainless steel, SB-167	Up to 288°C (550°F), reactor coolant water	Crack initiation and growth/ Stress corrosion cracking, intergranular stress corrosion cracking, cyclic loading	Chapter XI.M8, "BWR Penetrations," and Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515)	No

IV **Reactor Vessel, Internals, and Reactor Coolant System**
A1. Reactor Vessel (Boiling Water Reactor)

Item	Structure and/or Component	Material	Environment	Aging Effect/ Mechanism	Aging Management Program (AMP)	Further Evaluation
A1.5-b A1.5.1 A1.5.2 A1.5.3 A1.5.4 A1.5.5 A1.5.6	Penetrations Control rod drive stub tubes Instrumentation Jet pump instrument Standby liquid control Flux monitor Drain line	Stainless steel, SB-167	Up to 288°C (550°F), reactor coolant water	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA
A1.6-a	Bottom head	SA302-Gr B, SA533-Gr B with 308, 309, 308L, 309L cladding	Up to 288°C (550°F) reactor coolant water	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1)(i) and (ii), and for addressing environmental effects on fatigue. See Chapter X.M1 of this report for meeting the requirements of 10 CFR 54.21(c)(1)(iii).	Yes, TLAA
A1.7-a	Support skirt and attachment welds	SA533-Gr B (Welds low-alloy steel)	Ambient temperature air	Cumulative fatigue damage/ Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period of extended operation. See the Standard Review Plan, Section 4.3 "Metal Fatigue," for acceptable methods for meeting the requirements of 10 CFR 54.21(c)(1).	Yes, TLAA