April 13, 2001

Mr. Roger A. Newton, Chairman
Westinghouse Owners Group
Wisconsin Electric Power Company
231 West Michigan
Milwaukee, Wisconsin 53201

SUBJECT: ACCEPTANCE FOR REFERENCING OF GENERIC LICENSE RENEWAL PROGRAM TOPICAL REPORT ENTITLED, “AGING MANAGEMENT EVALUATION FOR THE PRESSURIZED WATER REACTOR CONTAINMENT STRUCTURE” WCAP-14756, REVISION 0, DECEMBER 1996

Dear Mr. Newton:

The staff of the U.S. Nuclear Regulatory Commission has reviewed the topical report entitled, “Aging Management Evaluation for the Pressurized Water Reactor Containment Structure,” WCAP-14756, Revision 0 which the Westinghouse Owners Group (WOG) submitted in December 1996, as part of the Generic License Renewal Program (GLRP). The resultant final safety evaluation report (FSER) is transmitted to you as an enclosure to this letter. We prepared this FSER after reviewing the technical evaluation report (TER) developed under contract by Brookhaven National Laboratory. We concur with the findings of the TER.

In a letter dated March 1, 2001, the WOG requested the staff to revise the Renewal Applicant Action Item 28 as delineated in the draft safety evaluation of January 31, 2001, and proceed with the final safety evaluation report on WCAP-14756. Accordingly, the staff revised the FSER.

As indicated in the FSER, the staff found the topical report acceptable for GLRP members’ plants to reference in a license renewal application to the extent specified and under the limitations delineated in the staff FSER and the associated topical report. The limitations include committing to the accepted aging management programs defined in the topical report, and completing the renewal applicant action items described in Section 4.0 of the FSER. An applicant referencing the topical report and meeting these limitations will provide sufficient information for the staff to make a finding that there is reasonable assurance that the applicant will adequately manage the effects of aging so that the intended functions of the containment covered by the scope of the report will be maintained consistent with the current licensing basis during the period of extended operation.

The staff does not intend to repeat its review of the matters described in the report and found acceptable in the FSER when the report appears as reference in a license renewal application, except to ensure that the material presented applies to the specified plant.

In accordance with the procedures established in NUREG-0390, “Topical Report Review Status,” the staff requests that the WOG publish the accepted version of WCAP-14756 within three months after receiving this letter. In addition, the published version will incorporate this letter and the enclosed FSER between the title page and the abstract.

To identify the version of the published topical report that was accepted by the staff, the staff requests the WOG include “-A” following the topical report number (e.g., WCAP-14756-A).

Sincerely,

/***RA***/

Christopher I. Grimes, Chief
License Renewal and Standardization Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Project No. 686

Enclosure: Final Safety Evaluation Report

cc w/encl: See next page

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FINAL SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
CONCERNING
WESTINGHOUSE OWNERS GROUP
GENERIC TECHNICAL REPORT WCAP-14756
REVISION 0, DECEMBER 1996
"AGING MANAGEMENT EVALUATION FOR THE
PRESSURIZED WATER REACTOR CONTAINMENT STRUCTURE"

1.0 INTRODUCTION

Pursuant to Section 50.51 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.51), the U.S. Nuclear Regulatory Commission (NRC) issues licenses to operate nuclear power plants for a fixed period of time not to exceed 40 years; however, the NRC may renew these licenses for a fixed period of time not to exceed 20 years beyond expiration of the current operating license. The Commission's regulations in 10 CFR Part 54, published May 8, 1995, set forth the requirements for the renewal of operating licenses for commercial nuclear power plants.

Applicants for license renewal are required by the license renewal rule to perform an integrated plant assessment (IPA). The first step of the IPA, required by 10 CFR 54.21(a)(1), is to identify and list structures and components that are subject to an aging management review; 10 CFR 54.21(a)(2) requires the applicant to describe and justify the methods used in meeting the requirements of 10 CFR 54.21(a)(1); and 10 CFR 54.21(a)(3) requires that, for each structure and component identified under 10 CFR 54.21(a)(1), the applicant demonstrate that the effects of aging will be adequately managed so that the intended function or functions will be maintained consistent with the current licensing basis (CLB) for the period of extended operation. Furthermore, the applicant must provide an evaluation of time-limited aging analyses (TLAAs), as required by 10 CFR 54.21(c), including a list of TLAAs, as defined in 10 CFR 54.3.

By letter dated December 11, 1996, the Westinghouse Owners Group (WOG) submitted the generic technical report (GTR) WCAP-14756, "Aging Management Evaluation for the Pressurized Water Reactor Containment Structure," for staff review and approval. The GTR identifies aging mechanisms, and presents options for managing aging effects to ensure that the intended functions of systems, structures, and components (SSCs) are maintained. The GTR states that the aging management options are to be developed into programs by utilities requesting license renewal. The GTR provides generic technical bases for demonstrating that the aging management options will adequately manage aging effects to maintain intended functions of SSCs, in accordance with the CLB for an extended period of operation.

2.0 SUMMARY OF TOPICAL REPORT

WCAP-14756 describes three typical configurations of containment structures applicable to Westinghouse pressurized water reactors, the applicable containment boundary, associated structural components, applicable aging effects, aging management programs, and time-limited aging analyses (TLAAs). The content and organization of the GTR are described in more detail in Section 2 of the enclosed Technical Evaluation Report (TER) prepared by the Brookhaven National Laboratory.

Enclosure

3.0 EVALUATION

The staff, with technical assistance from Argonne National Laboratory and Brookhaven National Laboratory (BNL), reviewed the GTR, and issued requests for additional information (RAI). After reviewing the GTR and WOG's responses to the staff's RAI, BNL issued a technical evaluation report (TER). The staff reviewed the GTR, WOG's responses to the RAI, and the TER.

As a result of their review, BNL recommended specific renewal applicant action items (Section 4.1), open items (Section 4.2), and confirmatory items (Section 4.3). At the request of WOG, the staff has reflected all of the actions as applicant action items in the following evaluation. In addition, the WOG would append all of the responses to the RAI in the GTR; therefore, the staff has incorporated the recommended confirmatory items as part of its conclusions in this evaluation. RAI 33 requested missing publication dates for references and bibliography documents listed in Section 6.0 of the WOG GTR. The requested dates were provided in the WOG response to the RAI.

Individual license renewal applicants are expected to include a summary description of the programs and activities for managing the effects of aging and the evaluation of TLAAs in the FSAR supplement submitted with a license renewal application, in accordance with 10 CFR 54.21(d). This is Applicant Action Item 2.

The NRC staff has reviewed the BNL evaluation and concurs with the findings and recommended actions, as incorporated in the following safety evaluation. The staff has combined the open items in Section 4.2 of the TER with the applicant action items in Section 4.1 of the TER. The combined list is provided in Section 4 of this DSER.

3.1 Components and Intended Functions

The scope of the GTR is intended to be applicable to all domestic commercial nuclear power plants with the Westinghouse nuclear steam supply system. In referencing the GTR, a license renewal applicant should verify the applicability of the GTR to its plant. This verification should identify plant-specific data not covered by the GTR and that will be evaluated in the license renewal application. The extent of this verification should include: (i) verification that its plant is bounded by the GTR, (ii) a commitment to implement programs described as necessary in the GTR to manage the effects of aging during the period of extended operation, and (iii) verification that the programs committed to are conducted in accordance with appropriate regulatory controls (e.g. 10 CFR Part 50, Appendix B). Further, the renewal applicant will identify any deviations from the aging management programs which this GTR describes as necessary to manage the effects of aging during the period of extended operation or to maintain the functionality of the containment structure, and deviations from other information presented in the GTR (e.g., materials of construction). The renewal applicant will evaluate any such deviations in accordance with 10 CFR 54.21(a)(3) and (c)(1) on a plant-specific basis. This is Applicant Action Item 1.

As described in Section 3.1 of the TER, the GTR describes the various intended functions of the containment structure and structural components that are within the scope of license renewal. The following functions, which are specific to containment structures and are understood to be covered by the various intended functions, should be addressed explicitly in

the license renewal application: (1) providing structural or functional support of safety-related systems, structures, and components following a design basis accident (DBA); (2) serving as an external missile barrier consistent with the design and licensing basis; and (3) providing passive heat sinks during a DBA or station blackout in addition to the spray system. This is part of Applicant Action Item 1.

The GTR describes three containment types and associated structural components that are typically applicable to Westinghouse reactors. The description of the containment and structural components includes a range of configurations and dimensions, as described in Section 3.1.2 of the TER. In an RAI response, the WOG acknowledged errors in the basemat thickness range for Types 1, 2, and 3 containments and provided a corrected list.

Because of the variety of containment configurations and applicable structural components covered in the GTR, individual plant applicants will need to provide a comprehensive list of structures and components subject to an aging management review, the methodology used to develop this list as part of their license renewal applications, and the applicability of the GTR. Any components determined by the applicant to be subject to an aging management review for license renewal but not within the scope of the GTR need to be addressed in the license renewal application. This is Applicant Action Item 3.

Because of the potential for aging effects unique to plant-specific configurations of the containment structure and structural components, the license renewal application should augment the list of structures and components with cross-section drawings for the containment structures, and detailed drawings of the sand pocket region and other plant-specific features, if applicable. This is Applicant Action Item 4.

The application should also include legible drawings of equipment and penetration details as part of the description of the containment structure components. This is Applicant Action Item 5.

For prestressed concrete containments, the license renewal applications should indicate whether the tendon access gallery is included as a containment structure component subject to an aging management review. If it is, provide the details of the aging management review and the credited aging management program. If not, provide a technical basis for its exclusion, addressing the potential for degradation of the lower vertical tendon anchors resulting from the environmental conditions in the tendon access gallery. This is Applicant Action Item 6.

The GTR identified structural connections as containment structure components that require aging management in Table 2-1. However, there is no definition or description of structural connections in GTR Section 2.0. A definition and a description of the AMP for structural connections should be provided in individual license renewal applications. This is Applicant Action Item 25.

The GTR identified embedments as a containment structure components that require aging management in Table 2-1. However, there is no definition or description of embedments in GTR Section 2. A definition and a description of the AMP for embedments are needed. This is Applicant Action Item 26.

Upon successful completion of the applicant action items described above, the staff will be able to conclude that a license renewal application referencing WCAP-14756 will have satisfied the scoping requirements in 10 CFR 54.4(a) and 10 CFR 54.21(a)(1).

3.2 Effects of Aging

As described in Section 3.2.1 of the TER, the GTR provides a listing of primary and secondary aging effects for all containment structure component and aging mechanism combinations which are evaluated in detail in the TER.

The GTR broadly describes operating experience related to the assessment of aging effects applicable to the combinations of containment and structural component configurations and environments. However, individual plants may have unique operating experience that could define additional aging effects or affect the assessment of the effectiveness of aging management programs. Therefore, individual license renewal applications should discuss plant-specific operating experience relevant to age-related degradation of containment structure components and how this experience has been considered in the aging management review. This is Applicant Action Item 7.

For concrete containments, WOG described criteria that were relied on to exclude leaching of calcium hydroxide and reaction with aggregates as significant aging mechanisms. Individual applicants should verify that the original plant design and construction specifications satisfy these criteria. If this aging effect cannot be excluded, the applicant should describe the aging management program (AMP) which is credited to manage this aging effect. This is Applicant Action Item 8.

WOG also addressed the potential for thermal embrittlement of concrete, and concluded that concrete structures that do not experience localized temperatures substantially higher than the 200^{o}F limit in the ACI code will not lose their intended function as a result of thermal embrittlement. Therefore, individual renewal applications should describe whether local heating of containment concrete at the main steam and/or any other penetrations results in sustained concrete temperatures exceeding 200^{o}F. If this condition exists, the applicant would be expected to provide an aging management review and describe the credited aging management program. This is Applicant Action Item 9.

Upon successful completion of the applicant action items described above, the staff will be able to conclude that a license renewal application referencing WCAP-14756 will have addressed the aging effects applicable to the containment and structural components.

3.3 Aging Management Programs

As described in Section 3.3 of the TER, WOG identified seven aging management programs (AMPs) that would be relied on by individual plants in conjunction with the inspection and testing programs in the current licensing basis that are based on the ASME Code, the ACI Code and the approved Inservice Inspection Program.

In the response to RAIs, WOG clarified and augmented the GTR on several important details of the AMP descriptions. In the response to RAI 24, WOG acknowledged the necessity of

implementing Appendices VII and VIII of the ASME Code when ultrasonic examination is used. WOG stated that when implementing an aging management program that references Subsection IWE, and it is necessary to utilize augmented ASME Section XI NDE inspection methods, the training qualifications and certification of ultrasonic examination personnel will meet Appendix VII and Appendix VIII. In responses to RAIs 6, 7, 30 and 31 WOG corrected text errors in Table 3-1. RAI 20 clarified that AMP 5.5 refers to IWE examination categories taken from the 1989 Code Edition, instead of the 1992 Code Edition; in the response, WOG acknowledged this error and corrected examination categories.

Because of the variety in the individual plant licensing bases, inservice inspection programs and design codes, individual license renewal applicants will have to identify the codes, edition and/or date of codes and standards which govern plant containment design, inspection and repair. This is Applicant Action Item 10.

The GTR describes two programs to manage freeze-thaw where that aging effect is applicable, one for concrete containments and the other for concrete shield buildings. Therefore, individual license renewal applicants will have to specify whether freeze-thaw is an applicable aging mechanism which will be managed by AMP 5.1 or AMP 5.2 depending on the affected structure. If not, the applicant will be expected to provide the technical basis for its exclusion. This is Applicant Action Item 11.

Similarly, the GTR describes two programs to manage corrosion due to agressive chemical attack, one for concrete containments and the other for concrete shield buildings and foundation mats. Therefore, individual license renewal applicants will have to specify whether aggressive chemical attack is an applicable aging mechanism which will be managed by AMP 5.3 or AMP 5.4 depending on the affected structure. If not, the applicant will be expected to provide the technical basis for its exclusion. This is Applicant Action Item 12.

The extent to which ground water corrosion is an aging effect that warrants an aging management program depends on plant-specific site characteristics, the availability of chemistry data, and seasonal variations. Therefore, individual license renewal applicants are expected to provide details of the groundwater monitoring program and discuss potential seasonal variation in ground water chemistry. This is Applicant Action Item 13.

For prestressed concrete containments, the prestressing tendons would be inspected and maintained in accordance with Section IWL requirements in Section XI of the ASME Code. There are ingredients in the grease used to pack the tendons that could cause degradation of the concrete. Therefore, individual license renewal applicants should discuss plant experience with respect to tendon grease leakage and, if applicable, how the leakage will be managed; the application should also discuss the potential effects of grease leakage on the shear load capacity of the containment structure. This is Applicant Action Item 14.

Stress corrosion cracking (SCC) is a concern for dissimilar metal welds. For the period of extended operation, the staff concludes that ASME Section XI, IWE examination Categories E-B and E-F and augmented VT-1 visual examination of bellows assemblies and dissimilar metal welds would provide adequate inspection. Therefore, the license renewal applicant needs to describe its plant-specific program to address SCC for dissimilar metal welds. The

program should include stainless steel bellows assemblies, if the material is not shielded from a corrosive environment. This is Applicant Action Item 15.

Coatings are provided on structural elements as a protective feature. While WOG concluded that there is no need for an aging management program for coating degradation, the staff concurs with the BNL conclusion that coating inspection and repair is usually an integral part of the maintenance programs for steel structures. Therefore, license renewal applicants should discuss the plant-specific coatings monitoring and maintenance program and specify whether it is credited as an AMP for containment steel elements. This is Applicant Action Item 16.

For prestressed concrete containments, the GTR indicates that AMP 5.6 will be used to manage potential degradation of the containment post-tensioning systems. License renewal applicants should specify whether post-tensioning system degradation will be managed by AMP 5.6 (Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category L-B, Unbonded Post-Tensioning System, 1992 Code Edition with 1992 Addenda of the ASME Code) and the additional requirements delineated in 10 CFR 50.55a(b)2(ix). If not, the applicant should provide the technical basis for its exclusion. This is Applicant Action Item 17.

Settlement of the containment foundation is a potential aging mechanism which will be managed by AMP 5.7. The WOG indicated that most of the settlement occurs within the first 5 to 6 years of plant operation. Therefore, this is a plant-specific issue. The license renewal applicant should specify whether settlement is an applicable aging mechanism that will be managed by AMP 5.7. If not, the applicant should provide the technical basis for its exclusion. This is Applicant Action Item 18.

The GTR did not address the errosion of cement in sub-foundation layers of porous concrete basemats, because WOG considered that type of construction to be limited. Therefore, license renewal applicants should identify whether erosion of the porous concrete sub-foundation layer is an applicable aging effect and, if applicable, provide an aging management review and describe the aging management program. This is Applicant Action Item 19.

The “Draft Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants,” issued in 1997 and updated in April 2000, identifies ten (10) elements (attributes) as appropriate for an acceptable AMP. The staff has concluded based on operating experience and the assessment of effective maintenance programs that these ten elements will ensure an adequate aging management program. The GTR listed only six (6) attributes to form the basis for each aging management program. The GTR predates the Draft Standard Review Plan for the review of License Renewal Applications for Nuclear Power Plants, and states in Section 4.0 that the report only presents program attributes for the AMPs, and that plant-specific details of the AMPs will be developed during the preparation of license renewal applications. Therefore, applicants for license renewal will be responsible for developing and describing the plant-specific AMPs and addressing each of the ten elements specified in the Draft Standard Review Plan. This is Applicant Action Item 20.

The GTR does not commit to inspection of inaccessible areas when there is no indication of degradation of adjacent accessible areas, except when the potential for degradation is “event driven”; i.e., some unusual event has occurred which has the potential to degrade inaccessible

areas of the containment structures. Therefore, the GTR cannot be referenced by license renewal applicants for managing aging of inaccessible areas. Individual license renewal applicants are required to describe a program for inspection of inaccessible areas or adopt a program endorsed by the staff in similar applications. This is Applicant Action Item 27.
The aging effects in concrete due to leaching of calcium hydroxide and the alkali-aggregate reaction are identified in the GTR as not requiring aging management; however, this conclusion cannot be justified on such a broad generic basis and a plant-specific evaluation should be performed to determine if these aging effects warrant an aging management program. These aging mechanisms, if applicable, can be managed by ASME Code, Section XI, Examination Category L-A. This is a required inspection program, which will continue into the period of extended operation. The GTR identifies examination category L-A of IWL to manage freeze-thaw (AMP5.1) and to manage aggressive chemical attack and steel corrosion (AMP5.3), where applicable. According to the GTR, it may not be necessary to credit examination category L-A to manage these aging mechanisms if on a plant specific basis, the applicant determines these aging mechanisms are not applicable. Consequently, in these cases, examination category L-A would not be credited to manage concrete degradation and steel corrosion for License Renewal. In general, it is intended that maximum credit be taken for existing mandated programs (e.g., examination category L-A) in the development of an applicant's aging management program. The license renewal applicants should specify that they are implementing examination category L-A as an aging management program for containment concrete or propose a suitable alternative. This is Applicant Action Item 28.

Upon successful completion of the applicant action items described above, a license renewal application referencing WCAP-14756 will have addressed the aging management program requirements such that the staff can conclude that there is reasonable assurance that applicable aging effects will be adequately managed in accordance with 10 CFR 54.21(a)(3).

3.4 Time-Limited Aging Analyses

Time-limited aging analyses (TLAAs) are defined in 10 CFR 54.3, as described in Section 3.4 of the TER. The GTR evaluated TLAAs associated with component fatigue and loss of prestress loads.

The WOG GTR indicates that the license renewal applicant may update an existing design fatigue analysis to account for the additional years of plant operation or manage the effects of the aging through aging management programs. The GTR uses AMP 5.5 for managing the effects of fatigue during the renewal license period, and basically endorses the ASME Code Section XI surveillance and testing program. For components where fatigue TLAAs exist, this option would allow the fatigue Section III cumulative usage factors (CUF) to be exceeded during the period of extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to obtain staff review and approval on a case-by-case basis. For components where fatigue TLAAs do not exist (are not addressed in 10 CFR 54.21), aging effects due to fatigue can be addressed by either a Section III fatigue analysis (including the additional years for the period of extended operation) or by adequately managing these effects for the period of extended operation. This is Applicant Action Item 21.

Because of the variety of structural components covered by the GTR, applicants should specify the containment structure components which have fatigue design analyses, and provide plant-specific details of the TLAAs for prediction of cumulative fatigue usage through the period of extended operation. This is Applicant Action Item 22.

Some containment structure components may be susceptible to fatigue, but do not have a fatigue design analysis as part of the current licensing basis. The applicant should specify whether any plant-specific components do not have a fatigue TLAA, but warrant an aging management program. In addition to implementation of AMP 5.5, the staff would expect that the requirements of 10 CFR 50.55a would apply. This is Applicant Action Item 23.

WOG determined that the calculations to determine the prestress loss rate for the period of extended operation, for prestressed concrete containments, would be addressed by individual applicants. Individual applicants will be expected to provide plant-specific details of the TLAA for prediction of tendon prestress losses. This is Applicant Action Item 24.

Upon successful completion of the applicant action items described above, the staff will be able to conclude that a license renewal application referencing WCAP-14756 will have adequately addressed time-limited aging analyses in accordance with 10 CFR 54.21(c)(1).

4.0 RENEWAL APPLICANT ACTION ITEMS

The following renewal applicant action items are to be addressed in the plant-specific license renewal application that references the WOG GTR:

1. The license renewal applicant will (i) verify that its plant is bounded by the GTR, (ii) commit to implement programs described as necessary in the GTR to manage the effects of aging during the period of extended operation, and (iii) verify that the programs committed to are conducted in accordance with appropriate regulatory controls (e.g. 10 CFR Part 50, Appendix B). Further, the renewal applicant will identify any deviations from the aging management programs which this GTR describes as necessary to manage the effects of aging during the period of extended operation or to maintain the functionality of the containment structure, and deviations from other information presented in the GTR (e.g., materials of construction). The renewal applicant will evaluate any such deviations in accordance with 10 CFR 54.21(a)(3) and (c)(1) on a plant-specific basis.

   The following functions, which are specific to containment structures and are understood to be covered by the various intended functions, should be addressed explicitly in the license renewal application: (1) providing structural or functional support of safety-related systems, structures, and components following a design basis accident (DBA); (2) serving as an external missile barrier consistent with the design and licensing basis; and (3) providing passive heat sinks during a DBA or station blackout in addition to the spray system.

2. A summary description of the programs and activities for managing the effects of aging and the evaluation of TLAAs is to be provided in the license renewal FSAR supplement, in accordance with 10 CFR 54.21(d).

3. Individual plant applicants will need to provide a comprehensive list of structures and components subject to an aging management review and the methodology used to develop this list as part of their license renewal applications. Any components determined by the applicant to be subject to an aging management review for license renewal but not within the scope of the GTR are required to be addressed in the license renewal application.

4. Provide cross-section drawings for the containment structures, and detailed drawings of the sand pocket region and other plant-specific features, if applicable.

5. Provide legible drawings of equipment and penetration details as part of the description of the containment structure components.

6. For prestressed concrete containments, indicate whether the tendon access gallery is included as a containment structure component subject to an aging management review. If it is, provide the details of the aging management review and the credited aging management program. If not, provide a technical basis for its exclusion, addressing the potential for degradation of the lower vertical tendon anchors resulting from the environmental conditions in the tendon access gallery.

7. Discuss plant-specific operating experience relevant to age-related degradation of containment structure components and how this experience has been considered in the aging management review.

8. For concrete containments, verify that the original plant design and construction specifications satisfy the criteria which are relied upon to exclude leaching of calcium hydroxide and reaction with aggregates as significant aging mechanisms. If these mechanisms are not excluded, describe the aging management program (AMP) which is credited to manage the aging effects associated with these aging mechanisms.

9. For concrete containments, discuss whether local heating of containment concrete at the main steam and/or any other penetrations results in sustained concrete temperatures exceeding 200^{o}F. If this condition exists, provide an aging management review and describe the credited aging management program.

10. Identify the codes, edition and/or date of codes and standards which govern plant containment design, inspection and repair.

11. Specify whether freeze-thaw is an applicable aging mechanism which will be managed by AMP 5.1 or AMP 5.2, as applicable. If not, provide the technical basis for exclusion.

12. Specify whether aggressive chemical attack is an applicable aging mechanism which will be managed by AMP 5.3 or AMP 5.4, as applicable. If not, provide the technical basis for exclusion.

13. Provide details of the groundwater monitoring program and discuss potential seasonal variation in ground water chemistry.

14. For prestressed concrete containments, discuss plant experience with respect to tendon grease leakage and, if applicable, how the leakage will be managed; also discuss the potential effects of grease leakage on the shear load capacity of the containment structure.

15. Each license renewal applicant needs to describe its plant-specific program to address the stress corrosion cracking (SCC) for dissimilar metal welds, and for stainless steel bellows assemblies, if the material is not shielded from a corrosive environment. For the period of extended operation, ASME Section XI, IWE examination Categories E-B and E-F and augmented VT-1 visual examination of bellows assemblies and dissimilar metal welds are required or a suitable alternative proposed.

16. Discuss the plant-specific coatings monitoring and maintenance program and specify whether it is credited as an AMP for containment steel elements.

17. For prestressed concrete containments, specify whether post-tensioning system degradation will be managed by AMP 5.6 (Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category L-B, Unbonded Post-Tensioning System, 1992 Code Edition with 1992 Addenda of the ASME Code) and the additional requirements delineated in 10 CFR 50.55a(b)2(ix). If not, provide the technical basis for exclusion.

18. Specify whether settlement of the containment foundation is an applicable aging mechanism which will be managed by AMP 5.7. If not, provide the technical basis for exclusion.

19. Identify whether erosion of the porous concrete sub-foundation layer is an applicable aging mechanism; if applicable, provide an aging management review and describe the credited aging management program.

20. The GTR listed only six (6) attributes to form the basis for each aging management program. However, the "Draft Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants," dated April 21, 2000, identifies ten (10) elements (attributes) as appropriate for an acceptable AMP. The GTR predates the Draft standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants, and states in Section 4.0 that the report only presents program attributes for the AMPs, and that plant-specific details of the AMPs will be developed during the preparation of license renewal applications. Therefore, applicants for license renewal will be responsible for developing and describing the plant-specific AMPs and addressing each of the ten elements specified in the Draft Standard Review Plan.

21. The WOG GTR indicates that the license renewal applicant may update an existing design fatigue analysis to account for the additional years of plant operation or manage the effects of the aging mechanism through aging management programs. The GTR uses AMP 5.5 for managing the effects of fatigue during the renewal license period, and basically endorses the ASME Code Section XI surveillance and testing program. For components where CLB fatigue TLAAs exist, this option would allow the CLB fatigue Section III cumulative usage factors (CUF) to be exceeded during the period of

extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to obtain staff review and approval on a case-by-case basis. For components where CLB fatigue TLAAs do not exist (are not addressed in 10 CFR 54.21), aging effects due to fatigue can be addressed by either a Section III fatigue analysis (including the additional years for the period of extended operation) or by adequately managing these effects for the period of extended operation.

22. Specify the containment structure components and provide plant-specific details of the TLAAs for prediction of cumulative fatigue usage through the period of extended operation.

23. Specify those containment structure components for which fatigue is an applicable aging mechanism, but no CLB fatigue analysis based on a 40 year plant life exists. In addition to implementation of AMP 5.5, the requirements of 10 CFR 50.55a should be met.

24. For prestressed concrete containments, provide plant-specific details of the TLAA for prediction of tendon prestress losses through the period of extended operation.

25. The GTR identified structural connections as containment structure components that require aging management in Table 2-1. However, there is no definition or description of structural connections in GTR Section 2.0. A definition and a description of the AMP for structural connections are needed.

26. The GTR identified embedments as containment structure components that require aging management in Table 2-1. However, there is no definition or description of embedments in GTR Section 2. A definition and a description of the AMP for embedments are needed.

27. The GTR does not commit to inspection of inaccessible areas when there is no indication of degradation of adjacent accessible areas, except when the potential for degradation is “event driven”; i.e., some unusual event has occurred which has the potential to degrade inaccessible areas of the containment structures. Therefore, the GTR cannot be referenced by license renewal applicants for managing aging of inaccessible areas. Individual license renewal applicants are required to describe a program for inspection of inaccessible areas or adopt a program endorsed by the staff in similar applications.

28. The aging effects in concrete due to leaching of calcium hydroxide and alkali aggregate reaction are identified in the GTR as not requiring aging management. This is unacceptable because plant-specific evaluation of their applicability is needed. Therefore, if these aging mechanisms (leaching of calcium hydroxide and alkali aggregate reaction) are applicable, applicants would be required to propose a plant specific aging management program. Alternatively, applicant can credit the ASME Code, Section XI, Examination Category L-A as an adequate aging management program.

5.0 CONCLUSION

The staff reviewed the generic technical report (GTR) WCAP-14756, "Aging Management Evaluation for the Pressurized Water Reactor Containment Structure," submitted by Westinghouse Owners Group and the technical evaluation report on the GTR by Brookhaven National Laboratory (BNL). On the basis of its review, the staff concludes that, upon successful completion of the applicant action items, applicants referencing the GTR in a license renewal application will satisfy the requirements of 10 CFR 54.21(a)(3) and 54.21(c)(1), and the staff will have sufficient information to conclude that there is reasonable assurance that applicable aging effects will be adequately managed for the period of extended operation and applicable time-limited aging analyses have been evaluated in accordance with 10 CFR 54.29(a)(1) and (a)(2) for containment structure components within the scope of the GTR.

TECHNICAL EVALUATION REPORT (TER)

FOR

WESTINGHOUSE OWNERS GROUP
GENERIC TECHNICAL REPORT WCAP-14756
REVISION 0, DECEMBER 1996
"AGING MANAGEMENT EVALUATION FOR PRESSURIZED WATER REACTOR CONTAINMENT STRUCTURE"

PROJECT NO. 686

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NRC/NRR/DRIP/RLSB

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1.0 INTRODUCTION

Pursuant to Section 50.51 of Title 10 of the Code of Federal Regulations (10 CFR 50.51), licenses to operate nuclear power plants are issued by the U.S. Nuclear Regulatory Commission (NRC) for a fixed period of time not to exceed 40 years; however, these licenses may be renewed by the NRC for a fixed period of time not to exceed 20 years beyond expiration of the current operating license. The Commission's regulations in 10 CFR Part 54, published May 8, 1995, set forth the requirements for the renewal of operating licenses for commercial nuclear power plants (Reference 1).

Applicants for license renewal are required by the license renewal rule to perform an integrated plant assessment (IPA). The first step of the IPA, 10 CFR 54.21(a)(1), requires the applicant to identify and list structures and components that are subject to an aging management review; 10 CFR 54.21(a)(2) requires the applicant to describe and justify the methods used in meeting the requirements of 10 CFR 54.21(a)(1); and 10 CFR 54.21(a)(3) requires that, for each structure and component identified in 10 CFR 54.21(a)(1), the applicant demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis (CLB) for the period of extended operation. Furthermore, the applicant must provide an evaluation of time-limited aging analyses (TLAAs) as required by 10 CFR 54.21(c), including a list of TLAAs, as defined in 10 CFR 54.3.

1.1 Westinghouse Owners Group Generic Technical Report

By letter dated December 20, 1996, the Westinghouse Owners Group (WOG) submitted Generic Technical Report (GTR) WCAP-14756, "Aging Management Evaluation for the Pressurized Water Reactor Containment Structure," (Reference 2), for NRC staff review and approval. The objectives of this GTR are to (1) identify and evaluate aging effects that degrade components which affect systems or structures intended functions, (2) identify and evaluate time-limited aging analyses (TLAAs), and (3) provide options, in terms of activities and program attributes, to manage these aging effects, and if necessary address TLAAs. The aging management options provided in the GTR are to be developed into programs by utilities requesting license renewal. The GTR provides generic technical bases supporting a part of a demonstration that the management options adequately manage aging effects to maintain intended functions for systems, structures, and components, consistent with the current licensing basis, for an extended period of operation.

1.2 Applicability of the GTR

The GTR is intended to be applicable generically to domestic commercial nuclear power plants with the Westinghouse nuclear steam supply system (NSSS), as listed in Table 1-1 of the GTR. Use of the GTR, as referenced by a license renewal application, should include a verification of all the bounding information against plant-specific data. This verification should identify the applicability of the GTR to the plant and determine what plant-specific data are not covered by the GTR and will be evaluated as part of the license renewal application.

2.0 SUMMARY OF THE GENERIC TECHNICAL REPORT

The GTR describes different types, parts, and materials of Westinghouse pressurized water reactor (PWR) containments and their boundaries, and identifies and evaluates age-related degradation mechanisms and the TLAAs. The GTR also describes how the age-related

degradation can potentially degrade the intended functions of the PWR containment and identifies aging effects and TLAAs that require management. The GTR further provides aging management plan attributes, including their details and implementation guidance, that form the basis for programs to be developed and implemented by utilities to manage aging effects for the extended period of operation.

2.1 Intended Functions and Containment Structure Components

2.1.1 Intended Functions

The GTR indicates that the intended functions of the Pressurized Water Reactor (PWR) containment structure that are within the scope of license renewal include:

(1) ensuring the integrity of the reactor coolant pressure boundary

(2) ensuring the capability to shutdown the reactor and maintain it in a safe shutdown condition

(3) ensuring the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the 10 CFR 100 guidelines

(4) ensuring compliance with U.S. NRC regulations for environmental qualification (10 CFR 50.49) where intended functions (1) and (2) are included as a result of the structural support provided by the containment.

2.1.2 Containment Structure Components

Section 2 of the GTR describes the scope of the report. This includes the containment boundary, engineering and design data, identification of TLAAs, general maintenance practices, and a summary of the aging effects. The containment boundary consists of the interior and exterior surfaces of the reinforced concrete containment shell, including the basemat, or the interior surface of the steel containment and the exterior surface of the shield building, including the common basemat. The boundary includes all penetration assemblies in the containment shell, such as mechanical and electrical penetrations, the equipment and personnel hatches and the fuel transfer tube. For mechanical penetrations, the entire mechanical penetration assembly (except the process piping) and the welds to the process pipe are in the scope of the GTR. For electrical penetrations, all metallic components that are part of the containment pressure boundary (but excluding nonmetallic seal materials) are in the scope of the GTR. The Westinghouse ice condenser, if part of the plant containment system, is not included in the scope of the GTR.

Three configurations of the PWR containment are addressed in the report. These include:

(1) Steel containment with reinforced concrete shield building
   a. with ice condenser
   b. no ice condenser

(2) Steel-lined reinforced concrete
   a. reactor building is atmospheric

b. reactor building is sub-atmospheric
c. reactor building is sub-atmospheric with ice condenser

(3) Steel-lined reinforced concrete with post-tensioning
a. three directional post-tensioning
b. vertical post-tensioning only

WOG divides the PWR containment into ten containment structure components (stated as parts or subcomponents in the GTR). These are the shell and dome, structural mat, structural connections, concrete reinforcing and tendons, steel liner, embedments, electrical penetrations including connectors, penetrations for gas and fluid systems that include isolation valves, fuel transfer tube, and equipment and personnel hatches that include seals. All of these containment structure components perform intended functions in a passive manner and are long-lived. Therefore, they are within the scope of 10 CFR Part 54 and are subject to an aging management review.

A listing of age-related degradation mechanisms applicable to PWR containment structures, a summary of containment aging evaluations, and an aging effects list are provided in GTR Tables 2-16, 2-17 and 2-18, respectively.

2.2 Effects of Aging

Section 3 of the GTR discusses the age-related degradation mechanisms that affect the PWR containment and evaluates time-limited aging analyses. The report states that the following aging mechanisms require aging management programs:

- Freeze-thaw of concrete
- Aggressive chemical attack on concrete
- Corrosion in reinforcing steel
- Corrosion of steel liners, steel containment shells, and penetrations
- Degradation in containment post-tensioning systems
- Mechanical wear and/or loss of pressure retention of airlocks and hatches
- Embrittlement of gaskets
- Stress corrosion cracking of penetrations and bellows
- Coating degradation
- Fatigue of penetrations and bellows

Table 3-1 of the GTR provides a summary of PWR containment structures aging evaluations and the status of applicable agreements reached between the Nuclear Energy Institute (NEI) and NRC. The table lists the aging degradation mechanisms, the corresponding aging effects, the components affected, the criteria/program used to evaluate them, and the applicable NEI/NRC agreements or positions. Detailed descriptions of the degradation mechanism, aging effect evaluation and aging effect management, for each aging degradation mechanism, are provided in Section 3.2 of the GTR.

2.3 Aging Management Programs

A summary listing of degradation mechanisms/effects managed by aging management programs, into the period of extended operation, is provided in Section 3.4 of the GTR. It is stated that aging mechanisms are adequately managed using seven aging management programs, AMP 5.1 through AMP 5.7, which are based on the current licensing basis (CLB), including ASME Code Section XI and ACI Code, inspection and test programs. Programs AMP 5.1 and AMP 5.2 address the aging effects due to freeze-thaw in concrete; programs AMP 5.3 and AMP 5.4 address the aging effects due to aggressive chemical attack of concrete and corrosion of the reinforcing steel; program AMP 5.5 addresses the aging effects for penetrations and liner/steel containment; program AMP 5.6 addresses the aging effects for the post-tensioning systems; and program AMP 5.7 addresses settlement of foundations. A detailed description of the aging management activities and programs is provided in Section 4 of the GTR. A listing of each program, along with the containment structure components managed, aging mechanism and aging effect, is provided in Table 4-2.

The GTR describes attributes of acceptable utility programs to manage aging effects for the extended period of operation. Table 4-1 of the GTR lists six (6) attributes intended to form the basis for aging management programs (AMPs) that will be developed and implemented by utilities during an extended period of operation. These attributes include scope of the program, surveillance techniques to be used to detect aging effects, frequency of the surveillance, acceptance criteria to determine when corrective actions are necessary, the corrective actions, and confirmation techniques. A summary description of the attributes of each aging management program, with code references to ASME Section XI, 1992 Edition with 1992 addenda (Reference 3) and ACI codes and standards, where applicable, is provided in Tables 4-9 through 4-15 of the report.

2.4 Time Limited Aging Analyses

It is stated in Section 3.3 of the GTR that prestress force losses and fatigue have the potential to be defined as TLAA effects. The TLAAs potentially applicable are:

- analytical prediction of time-dependent loss of prestress force loads in prestressing systems

- number of fatigue cycles at penetration anchors in concrete containments, and where appropriate, calculated cumulative fatigue usage factors

- number of fatigue cycles in bellows of mechanical penetrations, and where appropriate, calculated cumulative fatigue usage factors

- number of fatigue cycles of mechanical penetrations, and where appropriate, calculated cumulative fatigue usage factors

3.0 EVALUATION

BNL reviewed the GTR and the responses to the staff's RAIs to determine if WOG has demonstrated that the effects of aging of the containment structure components will be

adequately managed so that the intended functions will be maintained, consistent with the CLB, for the period of extended operation.

The license renewal applicant will (i) verify that its plant is bounded by the GTR, (ii) commit to programs described as necessary in the GTR to manage the effects of aging during the period of extended operation and (iii) verify that the programs committed to are conducted in accordance with appropriate regulatory controls (e.g., 10 CFR Part 50, Appendix B). Further, the renewal applicant will identify any deviations from the aging management programs which this GTR describes as necessary to manage the effects of aging during the period of extended operation or to maintain the functionality of the containment structure, and deviations from other information presented in the GTR (e.g., materials of construction). The renewal applicant will evaluate any such deviations in accordance with 10 CFR 54.21(a)(3) and (c)(1) on a plant-specific basis. This is Renewal Applicant Action Item No. 1 (see Section 4.1).

10 CFR Part 54.21(c) requires an evaluation of TLAAs. BNL reviewed the report and the responses to the staff's RAIs submitted by the WOG to determine if the TLAAs covered by the report were evaluated for license renewal in accordance with 10 CFR 54.21(c)(1).

A summary of description of the programs and activities for managing the effects of aging and the evaluation of TLAAs is to be provided in the license renewal FSAR supplement, in accordance with 10 CFR 54.21(d). This is Renewal Applicant Action Item No. 2.

3.1 Intended Functions and Containment Structure Components

3.1.1 Intended Functions

The GTR indicates that the following PWR containment structure component intended functions are within the scope of license renewal as described in 10 CFR 54.4:

(1) Ensuring the integrity of the reactor coolant pressure boundary

(1) Ensuring the capability to shutdown the reactor and maintain it in a safe shutdown condition

(2) Ensuring the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure comparable to the 10 CFR 100 guidelines

(3) Ensuring compliance with U.S. NRC regulations for environmental qualification (10 CFR 50.49)

BNL agrees with the above assessment, but finds that the following three additional functions, which are unique to containment structures, should be added to the intended functions identified above.

(1) Providing structural or functional support of safety-related systems, structures, and components following a design basis accident (DBA).

(2) Serving as an external missile barrier consistent with design basis commitments.

(3) Providing a heat sink during a DBA or station blackout in addition to the spray system.

The above identified functional additions are designated as Open Item No. 1 (see Section 4.2).

3.1.2 <u>Containment Structure Components</u>

The WOG considered three PWR containment types and their variations. These included steel containments with and without ice condensers; steel-lined reinforced concrete containments which are atmospheric, sub-atmospheric, and sub-atmospheric with ice condenser; and steel-lined reinforced concrete containments with three-directional or vertical-only post-tensioning. For the steel containment, the reinforced concrete shield building was considered part of the containment.

The WOG divided the containments into ten containment structure components:

- Shell and dome
- Structural foundation mat
- Structural connections
- Concrete reinforcing and tendons
- Steel liner
- Embedments
- Electrical penetrations including connectors
- Penetrations for gas and fluid systems that include isolation valves
- Fuel transfer tube
- Equipment and personnel hatches that include seals

The following sections discuss the containment structure components evaluated in the GTR. The staff notes, however, that the report is generically applicable to nuclear power plants with a Westinghouse NSSS and does not necessarily constitute a complete listing of the containment structure components subject to an aging management review for the WOG member plants, as required by 10 CFR 54.21(a)(1). In addition, WOG does not describe and justify the methodology for the generation of such a list, as required by 10 CFR 54.21(a)(2). Therefore, individual plant applicants will need to (1) provide a list of the plant-specific containment structure components subject to an aging management review, and (2) describe and justify the methodology used to develop this list, as part of their license renewal applications. This issue is designated as Renewal Applicant Action Item No. 3.

In RAI No. 5 (NRC letter dated February 19,1998), the staff requested WOG to provide cross-section drawings and configuration descriptions for other types of containments (i.e. Types 1a, 1b, 2a, 2b, 2c, 3a and 3b) which were not included in the GTR, and figures showing details of the sand pocket region and embedded shell region. In response, WOG indicated that the figures included in the GTR were provided to show the general type of configurations for the three types of Westinghouse PWR containments, and that the subtypes and other plant-specific features will be included in the plant license renewal application. This issue is designated as Renewal Applicant Action Item No. 4.

Since many of the sketches of equipment details presented in the GTR are not legible (e.g. Figures 2-2, 2-7, 2-10 and 2-13), the staff requested in RAI No. 32 (NRC letter dated

February 19,1998) that clear and legible figures be provided. In response (letter dated May 29, 1998), WOG indicated that the sketches in the GTR provide overall general characteristics of the different configurations and types, and do not provide details to the level requested in the RAI. WOG indicated that the requested details would be provided as needed as part of the license renewal application. This issue is designated as Renewal Applicant Action Item No. 5.

3.1.2.1 Containment Shell and Dome

The configurations of the PWR containment vary from plant to plant. WOG grouped them into three basic configuration types; steel containment with reinforced concrete shield building, steel-lined reinforced concrete, and steel-lined reinforced concrete with post-tensioning. Only the general type of configurations for the three types of containment are addressed within the GTR. WOG stated that subtypes within the general types, along with plant-specific features (e.g., sand pocket regions), will be included in the plant-specific license renewal applications.

3.1.2.1.1 Steel Containment with Reinforced Concrete Shield Building

The containment function is performed by a steel containment vessel in combination with a separate reinforced concrete shield building that surrounds the steel containment. The shield building has a vertical right cylinder wall, supported on a flat circular basemat and capped with a hemispherical dome. The containment vessel is a free standing steel structure consisting of a cylindrical wall, a hemispherical dome, and a bottom liner plate enclosed in concrete. The vessel is typically anchored to the shield building foundation with anchor bolts welded around the circumference of the base. The containment and shield building are separated by an annular air space. The air space and containment, or just the airspace is maintained at sub-atmospheric pressure. The containment may be equipped with an ice condenser (vapor suppression), designated Type 1a by WOG, or may be without an ice condenser (dry suppression), designated Type 1b by WOG. The ice condenser system, if used, is located inside the containment, between the crane wall and the steel shell. The ice condenser system is excluded from the scope of the GTR.

The steel containment vessel is typically 115 feet in diameter and 171 feet in overall height. The bottom liner plate is 1/4 inch thick, anchored to the foundation slab, and covered by a reinforced concrete floor slab 2 feet in thickness. The thickness of the cylinder wall and dome may be uniform or vary with height. If uniform, the typical thicknesses are 3/4 inches and 11/16 inches, for the wall and dome respectively. If non-uniform, the cylinder wall thickness typically varies from 1-3/8 inches at its base to ½ inch at the spring line. The dome varies from 7/16 inches at the spring line to 15/16 inches at its apex. On the exterior surface of the vessel, either circumferential and vertical stiffeners or circumferential ring girders with vertical stringers are fitted. Local shell thickening is provided at penetrations.

The typical shield building has a cylindrical wall 127 feet in diameter and 3 feet thick. The dome inner radius is 87 feet and the dome thickness ranges from 24 to 30 inches. The containment basemat slab has a diameter greater than the shield building wall and is stated to range in thickness from 6 to 9 feet. The cylinder wall reinforcing steel is applied throughout the structure in a horizontal and vertical pattern near the inner and outer surface. The vertical reinforcement is continued into the dome and extended into the basemat. Penetrations smaller than 12 inches fit within the reinforcing steel pattern. For penetrations larger than 12 inches the reinforcement is formed in hoops around the opening. The dome reinforcement is arranged in

a radial and circumferential pattern with the radial bars being an extension of the wall vertical bars. The slab reinforcement consists of concentric and radial bars at the top and bottom surfaces.

Upon review of the information presented in the GTR, the staff noted that the minimum containment basemat thickness is essentially four feet for containment types 1a and 1b and can be as low as two feet for Type 3 containments. This was addressed in RAI No. 29 (NRC letter dated February 19,1998). WOG agreed with the staff's comment in its response to the RAI (WOG letter dated May 29, 1998) and indicated that appropriate corrections would be made in the GTR. This issue is designated as Confirmatory Item No. 1 (see Section 4.3).

3.1.2.1.2 Steel-Lined Reinforced Concrete Containment

The structure is a vertical cylinder capped with a hemispherical dome supported on a flat basemat. It is designated Type 2 by the WOG. It may be designed to operate at sub-atmospheric pressure to limit leakage.

The reinforced concrete cylinder is 4 to 4-1/2 feet thick, with an inside diameter of 140 feet and a length of 131 feet. The dome has an inside radius of 70 feet and a thickness of 2-1/2 to 3-1/2 feet. The basemat diameter varies from 153 to 158 feet and the thickness varies from 6 to 10 feet. Steel reinforcement is arranged horizontally and vertically, and supplemented with diagonal reinforcement, in the cylinder wall. Steel reinforcement is arranged meridionally and horizontally in the dome. Steel reinforcement is arranged in a rectangular grid at the bottom of the basemat and in a concentric and radial grid at the top of the basemat. All reinforcement is located near the concrete surfaces. The cylindrical wall vertical steel reinforcement extends into both the dome and basemat.

3.1.2.1.3 Steel-Lined Reinforced Concrete Containment with Post-Tensioning

This containment, designated Type 3, is similar to the Type 2 containment except that post-tensioning tendons are used in addition to the conventional steel reinforcement in the concrete cylinder wall and dome. The Type 3a containment uses three directional post-tensioning while Type 3b uses vertical post-tensioning only.

The cylindrical wall portion of the Type 3a containment is prestressed by a post-tensioning system composed of horizontal and vertical tendons. The horizontal tendons are either placed in three 240 degree segments using three vertical buttresses spaced 120 degrees apart, or in six 120 degree segments using six vertical buttresses spaced 60 degrees apart. The three way dome tendons are anchored at the sides of the ring girder. A continuous tendon access gallery is provided beneath the base slab for the installation and inspection of the vertical tendons.

The vertical tendons are anchored at the top of the ring girder at the dome periphery and at the bottom of the foundation slab. The horizontal tendons are anchored at two buttresses spaced either 240 degrees apart, or 120 degrees apart, for the three buttress and six buttress configurations, respectively. In either configuration the horizontal tendons pass through one intervening buttress. All tendons are continuous and are bent to curve around major penetrations.

The cylinder wall portion of a Type 3b containment is reinforced circumferentially and prestressed vertically. The prestressing system consists of a number of tendons placed at intervals around the periphery at the cylinder wall centerline. The tendons are composed of a number of high strength steel bars or steel wire. Each tendon is sheathed with a 6 inch galvanized steel pipe or a galvanized corrugated steel tube or conduit. Corrosion protection of post-tensioned steel tendons is provided by filling the sheath with microcrystalline petrolatum containing organic-based corrosion inhibitors. For one Westinghouse plant, the H. B, Robinson Unit 2, corrosion protection is provided by filling the ducts with portland cement grout.

In RAI No. 9 (NRC letter dated February 19,1998), the staff questioned whether the tendon access gallery is part of the containment structure and whether it is subject to aging management review for license renewal. If the tendon access gallery is not considered part of the containment structure, the concern is that degradation of the tendon gallery could lead to degradation of the tendon prestressing system.

In its response, WOG indicated that tendon access galleries are not generically considered to be part of the containment. Therefore, access galleries are only subject to aging management review if they are considered, on a plant-specific basis, to support the integrity of the prestressing system. WOG indicated that the above statement would be noted in the plant-specific license renewal application. The issue of plant-specific discussion of its tendon access gallery is designated as Renewal Applicant Action Item No. 6.

3.1.2.2 Foundations

PWR containment foundations typically consist of a reinforced mat that is supported on rock, soil, or a deep foundation such as piles. Pile foundations are not within the scope of the GTR and, if used, are to be addressed in the plant-specific application for licence renewal.

3.1.2.3 Structural Connections

Structural connections have been identified as a containment structure component by WOG. However, no specific description of structural connections is provided in Subsection 2.3 of the GTR. A definition and description of structural connections needs to be added to this subsection. This issue is designated as Open Item No. 2.

3.1.2.4 Concrete Reinforcement and Tendons

Concrete reinforcement was placed to meet the requirement of the applicable codes and standards. Different code editions are used based on the vintage of the plant. The arrangement of reinforcing steel varied somewhat between containment types. For the shield building the vertical reinforcement steel continues from the cylindrical wall to the dome and extends into the foundation slab. In the wall, steel reinforcing bars are applied throughout the structure and placed in a horizontal and vertical pattern near each face. No special reinforcement is provided near penetrations less than 12 inches in diameter. For larger penetrations reinforcement steel is either terminated at the opening and supplemental steel added, or the reinforcement is continuous and is bent to curve around the opening. Dome reinforcement is arranged in a radial and circumferential pattern, where the radial bars are continued from the vertical cylinder bars. Additional reinforcement schemes may be used. The slab reinforcement pattern consists of concentric circular bars combined with radial bars, at the

top and bottom face, arranged to permit uniform spacing of the vertical wall rebar that extends into the mat.

For the steel-lined reinforced concrete containment and the steel-lined reinforced concrete with post-tensioning containment the wall reinforcement consists of horizontal bars located near both faces of the wall and rows of vertical bars placed near each face, supplemented by inclined bars. The dome reinforcement consists of meridional and horizontal hoop bars. In the basemat the bottom reinforcement is a rectangular grid pattern, while the top rebar consists of concentric circular bars combined with radial bars that are arranged to permit a uniform spacing of the vertical wall bars that extend into the basemat.

A tendon may consist of a number of 1/4 or ½ inch diameter steel wires or a single round steel bar. The tendons are anchored to a bearing plate. The tendons are installed in metal sheaths that form ducts through the concrete between anchorage points. The sheaths, after venting and draining, are filled with a grease used for permanent tendon corrosion protection. The grease is a modified, refined petroleum oil based product that is pumped into the sheathing after tendon installation.

3.1.2.5 Steel Liner

The steel liner is made up of a cylinder capped with a hemispherical dome and attached at the bottom to a mat liner completely lining the concrete vessel. The wall, dome and mat liner plate thicknesses are 3/8, ½ and 1/4 inches, respectively. The liner plate is a continuously welded steel membrane supported and anchored to the inside of the containment and designed to maintain a leaktight integrity. The liner pressure boundary includes embedments, insert plates, and penetrations. Leak chase channels are installed over liner seam welds which include mat, wall, dome and penetrations. The basemat liner plate is anchored to the foundation slab using two methods. Either the liner is welded to a ring plate that is anchored in the base slab and then welded to the skirt ring of the wall liner; or the liner plate is directly anchored with embedded stiffeners and anchors. A reinforced 2 foot thick concrete slab is poured over the liner plate and may or may not be anchored through the floor liner to the basemat.

3.1.2.6 Embedments

Embedments have been identified as a containment structure component by WOG. However, no specific description of embedments is provided in Subsection 2.3 of the GTR. A definition and description of embedments needs to be added to this subsection. This issue is designated as Open Item No. 3.

3.1.2.7 Electrical Penetrations

The scope of this evaluation includes the metallic components of the typical electrical penetrations that are part of the containment pressure boundary. Seal materials such as epoxy and silicone rubber are not included in the scope of the GTR. There are generally four types of electrical cable penetrations required in the containment depending on the type of cable involved:

- Medium voltage power, 4160 V or 6.9 kV
- Low voltage power, control and instrumentation, 600 V and lower

- Thermocouple leads
- Special instrumentation coaxial and triaxial circuits

Typically, medium and low voltage electrical penetrations consist of carbon steel pipe canisters with stainless steel header plates bolted to one or both of the ends. Identical, hermetically sealed ceramic multi-pin connectors are mechanically connected to the header plate(s) for all conductors rated less than 600 volts. High voltage conductors use single-conductor, hermetically sealed ceramic bushings, also mechanically connected to both header plates. A flange on each canister is welded to the penetration sleeve. The electrical penetration assembly permits pressure and leakage tests to be performed at the shop and after installation in the containment. A tap, convenient to the exterior of the containment, is provided for pressurizing the canister. The terminations of the conductors to the connectors inside the canisters are potted to protect against moisture. A plug is provided to permit purging with dry nitrogen.

Penetration assemblies for Westinghouse containments, were manufactured and supplied by four major vendors:

- Westinghouse Electric Corporation
- Conax Corporation
- D.G. O'Brien
- Bunker Ramo

Of these four, D.G. O'Brien and Bunker Ramo are no longer in business. Westinghouse and Conax are the two vendors that currently supply penetration assemblies and provide the necessary services for penetrations supplied by D.G. O'Brien or Bunker Ramo.

During an EQ inspection, the U.S. NRC identified a deficiency in the Bunker Ramo low voltage penetration qualification testing method. The deficiency is detailed in Information Notice 88-29. The notice states that the insulation resistance (IR) measurements performed during the accident simulation testing were not frequent enough to evaluate the impact of the IR values on the accuracy of the connected instrument circuits.

For the steel containment, the nozzle that is welded into the steel containment plate and the steel header plate for the electrical terminals are included in the scope. The wiring, sealing compound, fixtures to hold the sealing compound, and seal welds, which connect the fixtures to the header plate, are not included in the scope of this evaluation.

3.1.2.8 Penetrations for Gas and Fluid Systems that Include Isolation Valves

The mechanical penetrations, or piping penetrations, are provided for fluid carrying pipes and for air purge ventilating piping. In certain steel containment designs, vacuum breaker penetrations are provided through the steel containment and into the annulus between the containment and the shield building. Various systems are used to classify the piping penetrations for design purposes. In general, the classification is based on whether thermal movement of the process line is expected. The piping penetrations are typically classified into high or moderate temperature service. A third type of penetration is a multiple pipe penetration, where more than one line passes through the penetration. The multiple pipe penetrations

accommodate small-diameter tubes for sampling lines. Socket weld couplings may be welded into the penetration header plate to mate with the seamless tubing.

In steel containments, the penetration assemblies span from the inner wall of the containment shell to the outer wall of the concrete shield building. They provide containment leak tightness and support for the penetrating pipe, and also accommodate thermal movement of the pipe. The closure between the steel containment and the process pipe is provided either by a bellows assembly or by direct welding of the pipe to the steel shell. For high temperature penetrations, a bellows is used to permit relative movement between the pipe and the containment shell, while the pipe support loads are carried by the more robust concrete shield building wall.

Penetration closures for smaller lines and cold lines may be provided by direct welding of the pipe to the steel containment. In this case, a bellows assembly is provided at the concrete shield building to accommodate the differential building movements. Bellows assemblies may also be used for the closure to the steel containment for the cold and smaller lines. However, direct welding is typically provided, where feasible, because the rigid-plate-to-pipe weld provides a more reliable seal at the primary containment boundary than bellows details.

Mechanical (piping) penetrations for concrete containments may be classified as single barrier or double barrier penetrations. The single barrier penetration provides a single rigid closure between the containment liner and the process pipe. It may consist of a flued head, a standard pipe cap, or a plate with a segment of sleeve pipe. The double barrier penetration provides a closure barrier at both faces of the containment wall and is composed of a sleeve and multiple pipe caps. The penetrations in concrete containments provide a support point for the piping system. The robust cylindrical wall of concrete containments typically serves as an anchor point for hypothetical pipe rupture loadings from high energy lines such as main steam and feedwater.

For the high-temperature penetrations, design features are provided to limit the temperature in the concrete adjacent to the penetration (local area) to less than 200°F for normal operation, 350°F for short-term unusual conditions, and 650°F for jets due to postulated pipe rupture conditions. Systems to provide the necessary cooling range from active forced air or water cooling systems within the penetration sleeve to passive systems consisting of insulation and cooling fins. In some designs, thermocouples are placed in the concrete local to the penetration to monitor temperature in the concrete.

In general, piping penetration nozzles are designed and fabricated to conform to the ASME Code requirements in effect when the plant was built. For older plants, ASME Code Section III, Class B was used. For later plants, ASME Code Section III, Division 1, Subsection NE (Class MC) was used. Class MC penetration assemblies were code-stamped with the NPT stamp for nuclear parts.

In concrete containments, penetrations and anchorages to the concrete shell are designed for forces and moments resulting from operating conditions or postulated pipe rupture. External guides, stops, or increased pipe wall thickness are provided to limit stresses on the penetration and on the adjacent liner plate.

Penetration reinforcing plates and the welds of pipe sleeves to them are shop stress-relieved as a unit in accordance with the ASME Code requirements to ensure a minimum of field welding at

the penetrations. Full-penetration butt welds are used to connect the sleeve and the attachment hardware around the process piping. The closure between the sleeve and the process piping consists of flued heads, plates, or drilled pipe caps.

Spare penetrations for concrete containments generally consist of a sleeve with welded end cap closures. The arrangement and details are basically the same for steel containments except that the sleeve is welded to the steel containment plate rather than to the concrete containment liner. For some plants, spare penetrations that are used only during outages may incorporate bolted blind flanges with flexible seals for ease of removal and replacement.

The entire mechanical penetration assembly (excluding the process piping within the penetration) and the welds to the process pipe are included in the scope of the GTR. Flued heads, containment vessel nozzles, bellows assemblies and all other items that perform a containment function are in the scope of the GTR. For smaller piping and cold lines, if a bellows is not used, the closure weld between the containment steel and the process pipe is in the scope of the GTR. Piping insulation is not included, although in some cases the piping insulation also serves to maintain the temperature of the concrete adjacent to the penetration sleeve within permissible limits.

3.1.2.9 Fuel Transfer Tube

The fuel transfer tube penetrates the reactor building and links the refueling canal in the reactor building with the fuel transfer canal in the fuel handling building. For a concrete containment it consists of the transfer tube and a sleeve welded integrally into the containment liner. The closure between the transfer tube and the sleeve that is welded integrally into the containment liner typically consists of a circular plate shop-welded to the tube and a short segment of pipe to mate with the sleeve. All welds in the closure between the tube and liner are full-penetration welds except for the flange adaptor ring welded to the end of the tube. The blind flange adaptor ring is connected to the transfer tube pipe by two separate continuous partial penetration welds. For older vintage plants, the bimetallic transition weld between the stainless steel transfer tube and the carbon steel plate or pipe segment was shop-welded for better control of quality. For later plants, with improved welding materials and techniques, the transition weld was made in either the shop or field. For double-barrier designs, a welded canopy is placed over the connecting hardware between the tube and liner.

The fuel transfer tube penetration arrangement through a steel containment is basically the same as for the concrete containment with closure being made to the steel containment vessel rather than the containment liner. In some designs, the closure to the steel containment vessel may consist of a flexible bellows assembly.

During normal operation, the fuel transfer tube penetration is closed and serves as part of the containment pressure boundary. The closure at the pressure boundary end inside containment typically consists of a blind flange with double seals. The closure on the fuel handling building end outside the containment generally consists of a gate valve supported from the end of the transfer tube.

The scope of the GTR includes all parts of the fuel transfer tube that serve as part of the containment system such as the blind flange with double seals, the closure detail between the containment liner (or steel containment) and the transfer tube, and the transfer tube itself. In

addition, the gate valve at the outboard end of the transfer tube is included. The bellows assembly connections between the stainless steel canal liner and the transfer tube are not included in the scope of the GTR.

3.1.2.10 Equipment and Personnel Hatches that Include Seals

Typically, two personnel access airlocks are provided at two different floor levels of the containment for normal and emergency ingress and egress.

A typical personnel airlock through a concrete containment consists of a cylindrical barrel section with leaktight doors at each end. The airlock is supported by the concrete containment wall. Airlocks through steel containments are basically the same with the exception that they may be supported by the concrete shield building rather than the steel containment. The leaktight closure between the steel containment and the airlock barrel is by a flexible connection such as a bellows assembly.

For some containments, two different size airlocks are used. The larger airlock is typically used as the primary access and the smaller airlock for emergency access. In some containments, one of the personnel airlocks penetrates the dished cover of the equipment hatch.

The airlocks are designed to withstand all containment design conditions with either or both doors closed and locked. The doors open toward the center of the containment and are thus sealed under containment pressure. The airlock may be pressurized to demonstrate leaktightness without pressurizing the containment. Each airlock is pneumatically tested in the shop for pressure and leakage. Quick-acting equalizing valves connect the personnel lock with the interior and exterior of the containment vessel for the purpose of equalizing pressure in the two systems when entering or leaving the containment.

The two personnel airlock doors are interlocked to prevent both being opened simultaneously and to ensure that containment is always maintained by one door being completely closed before the other door can be opened. The interlocking system has the capability to be bypassed allowing the doors to be left open during plant cold shutdown. In most cases, operation of the lock is manual, without power assist.

Each airlock door is provided with flexible seals. The arrangement and type of seal varies from plant to plant. In most cases, either double gasket seals that have provisions for local leakage testing between the seals or inflatable seals are provided.

Airlocks are designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section III. In most cases, the airlocks are code-stamped in accordance with the requirements for Code Class MC. For plants built prior to the ASME incorporation of Subsection NE for Class MC, the portions of the airlocks not backed by concrete typically conformed to ASME Section III for Class B requirements, but were not code-stamped.

The scope of the GTR includes each entire airlock including the equalizing valves, handwheel shaft seals, and door seals. Electrical penetrations of the airlock bulkheads are not included.

The typical equipment hatch consists of a double-gasketed flange, a bolted dished head and a barrel liner sleeve through the containment wall. Supplementary equipment such as a monorail

and hoist system are usually associated with the equipment hatch to permit efficient usage of the large opening. In later-generation plants, the hatch diameter is typically sized to permit removal and replacement of a steam generator. In the older plants, the diameter is adequate to support most maintenance activities but does not permit passage of an intact steam generator. In some cases, a smaller diameter emergency access personnel airlock is incorporated into the equipment hatch head, providing a dual function design.

The hatch design and fabrication conforms to the applicable ASME Code requirements in effect for the particular vintage plant. The hatch may be ASME code-stamped for the later vintage plants but is not stamped for the early plants. Typically, the head is convex inward toward the design pressure. The space between the double gaskets on the hatch flange can be pressurized for local leakage checking. The diameter ranges from 14 to 24 feet. The smaller diameter hatches in the earlier plants were designed to accommodate replacement of the reactor vessel O-ring seal. The larger diameter hatches provided in the later plants were sized for steam generator replacement.

Equipment hatch designs are basically the same for both concrete and steel containments. The scope of the GTR includes the entire hatch including the flexible seals between the hatch barrel flange and the head flange.

3.2 Effects of Aging

Section 2.7 of the GTR discuses the potential aging mechanisms and associated aging effects applicable to PWR containments. Tables 2-16, 2-17, and 2-18 of the GTR summarize the potential aging mechanisms and aging effects considered in the “Aging Management Review,”which is documented in GTR Subsections 3.2.1 thru 3.2.40. GTR Section 3.4 "Aging Effect Evaluation Summary” lists the containment component/aging mechanism combinations that WOG has identified as requiring an aging management program for License Renewal.

The following paragraphs provide the evaluation of the GTR Sections delineated above.

3.2.1 Potential Aging Mechanisms and Associated Aging Effects

GTR Table 2-16 lists the age related degradation mechanisms applicable to PWR containment structures correlated in accordance with the material and component affected. Mechanisms that affect concrete, reinforcing steel, prestressing system components and steel components, in both concrete and steel containments are listed.

BNL considers the aging mechanism list provided in GTR Table 2-16 to be a reasonable summary of the aging mechanisms that potentially affect PWR containment structures. However, two additional potential aging mechanisms should have been listed: erosion of porous concrete subfoundation layers, and grease leakage in concrete containments. These aging mechanisms are discussed in Section 3.3 of this TER. It is also noted that wear and seal degradation for penetrations, hatches and airlocks are not included in Table 2-16; they are, however, included in Table 2-17.

With inclusion of the items noted, the staff considers the degradation mechanism list provided in GTR Table 2-16 to be an acceptable summary of the aging mechanisms that can potentially affect PWR containment structures.

GTR Table 2-17 provides a summary of the aging evaluations performed by WOG for each containment structure component/aging mechanism combination described in subsections 3.2.1 thru 3.2.40 of the GTR. For each containment structure component, the aging mechanisms that affect it and the associated aging effects are listed. Also provided is an identification of the aging management program that will be used to manage the aging effects and references to subsections of the GTR where the aging evaluation and TLAAs, if applicable, are discussed. As noted above, erosion of porous concrete subfoundation layers and grease leakage in concrete containments are not identified. See Section 3.3 of this TER.

GTR Table 2-18 provides a numbered listing of primary aging effects which are referenced by Table 2-17and two secondary effects, identified as A and B, which are also referenced in Table 2-17. The aging evaluations are described in GTR Subsections 3.2.1 thru 3.2.40, for all containment structure component/aging mechanism combinations which are identified in Table 2-17.

The aging effects considered for concrete include cracking, scaling, spalling, increased porosity and permeability, reduction in strength and modulus of elasticity. Other effects considered include loss of protective covering and chemistry (i.e., lowering concrete pH and degrading protective oxide films) on reinforcing steel, resulting in the corrosion of the embedded steel.

The aging effects resulting from corrosion of steel components in concrete include increase in volume through rust by-products, cracking of the surrounding concrete, and reduction in cross-sectional area or thickness. Elevated temperatures result in a reduction in strength and modulus of elasticity for steel, while irradiation embrittlement results in a increase in yield strength, decrease in the ultimate tensile ductility, and increase in the ductile-to-brittle transition temperature. A secondary effect of elevated temperature is loss of bond strength between embedded steel and concrete. Fatigue results in cracking in steel components and surrounding concrete.

The aging effects considered for corrosion in post-tensioning systems include decreases in cross-sectional area, reduction in prestress force, breakage of wires or strands, and leakage of corrosion inhibiting grease.

Aging effects associated with aging mechanisms that affect penetrations include loss of material, cracking of steel components, fatigue-induced cracking, and loss of seal or pressure retention.

The effect of foundation settlement is an increase of stress in piping or other systems interconnecting adjacent buildings, due to the additional movement between anchor points.

In RAI No. 3 (NRC letter dated February 19,1998), the staff requested the WOG to discuss the operating experience of the containment structure and its components relating to the effects of aging, including any applicable generic communications. In response, the WOG indicated that Sections 2 and 7 of the GTR provide a detailed description of the operating experience. In particular Section 2.6.3 describes survey data of maintenance and inspection history from the International Atomic Energy Agency, Section 2.6.4 provides summaries of observed degradations associated with structures within the scope of the GTR, and in Section 7 (an appendix) a summary of age-related degradation observed in concrete containments is given for plants at four sites.

WOG further stated that license renewal applicants will discuss the results of past containment examinations, which will demonstrate the operating experience at their specific plant. Therefore, the submittal of plant-specific operating experience is designated as Renewal Applicant Action Item No. 7.

3.2.2 Aging Mechanisms Requiring an Aging Management Program

Table 2-17 provides a listing of the aging mechanisms and identifies the WOG aging management program (AMP), if any, that will be used to manage each mechanism. In Table 2-17, the aging mechanisms requiring an aging management program and the applicable WOG aging management programs are

Component	Aging Mechanism	Aging Management Program
Concrete	Freeze thaw (3.2.1)	AMP-5.1 and AMP-5.2
	Aggressive chemical attack (3.2.7)	AMP-5.3 and AMP 5.4
	Fatigue at penetration anchors (3.2.9)	AMP-5.5
Reinforcing Steel	Corrosion (3.2.10)	AMP-5.3 and AMP-5.4
Liner	Corrosion (3.2.14)	AMP-5.5
	Coating degradation (3.2.15)	AMP-5.5

Component	Aging Mechanism	Aging Management Program
Post-Tensioning Systems	Corrosion (including microbial) (3.2.17)	AMP-5.6
	Concrete degradation (3.2.17)	AMP-5.6
	Prestress force losses (3.2.20)	AMP-5.6
	Stress corrosion cracking (3.2.21)	AMP-5.6
Electrical Penetrations	Bellows TGSCC (3.2.24)	AMP-5.5
Mechanical Penetrations	Bellows fatigue (3.2.25)	AMP-5.5
	Fatigue (3.2.9, 3.2.26)	AMP-5.5
	Embrittlement of gaskets (3.2.27)	AMP-5.5
	Corrosion and SCC (3.2.28)	AMP-5.5
Fuel transfer Tube Penetration	Mechanical wear (3.2.29)	AMP-5.5
	Embrittlement of gaskets (3.2.30)	AMP-5.5
	Corrosion and SCC (3.2.28, 3.2.31)	AMP-5.5

Airlocks and Hatches	Mechanical wear (3.2.32)	AMP-5.5
	Gasket embrittlement(3.2.27, 3.2.34)	AMP-5.5
	Loss of pressure retention (3.2.35)	AMP-5.5
Foundations	Settlement (3.2.37)	AMP-5.7
Free-standing Steel containment	Fatigue (3.2.39)	AMP-5.5
	Corrosion (3.2.40)	AMP-5.5

Numbers in parentheses refer to the GTR subsection number which contains the corresponding aging evaluation.

3.2.3 Aging Mechanisms Not Requiring an Aging Management Program

WOG concluded that many aging mechanisms did not require an aging management program. These items are listed in Table 2-17 and are designated NR (not required) in the column titled Aging Management Program. Also listed in the table are the GTR report subsections in which an assessment of the listed aging effect/mechanism is provided.

The aging mechanisms for which no aging management program is considered necessary, grouped by containment structure component, are listed below. Numbers in parentheses refer to the GTR subsection number which contains the corresponding aging evaluation.

Component	Aging Mechanism
Concrete	Leaching (3.2.2), alkali aggregate reaction (3.2.3), neutron irradiation embrittlement (3.2.4), interaction with aluminum (3.2.5), thermal aging embrittlement (3.2.6), bond strength reduction - direct current (3.2.8)
Reinforcing Steel	Elevated temperature effects (3.2.11), irradiation embrittlement (3.2.12), fatigue (3.2.13)
	Liner Elevated temperature effects (3.2.11), irradiation embrittlement (3.2.12), fatigue (3.2.13), fatigue at attachments and discontinuities (3.2.16)
Post-tensioning	Elevated temperature effects (3.2.18), irradiation embrittlement (3.2.19) Systems
Steel Embedments	Corrosion (3.2.22)
Electrical Penetrations	Material compatibility (3.2.23)
Airlocks and Hatches	Fatigue (3.2.16, 3.2.33), elevated temperature effects (3.2.36)
Free-standing Steel	

Containment	Strain aging (3.2.38)

The staff raised several questions regarding the lack of aging management programs for various aging mechanisms. In Section 3.2 of the GTR, the aging effects in concrete due to leaching of calcium hydroxide and alkali aggregate reaction are identified as not requiring aging management because their effects have been determined not to be detrimental. In RAI No. 1 (NRC letter dated February 19,1998), the staff requested the WOG to address applicable aging effects such as those described in the working draft SRP-LR and to propose appropriate aging management programs for renewal, or provide detailed justifications for excluding any applicable aging effects.

The GTR and response to RAI No. 1 state that because plant construction used specific national codes, standards, and guides such as ACI 201.2R-77 and ASTM C295 or C227, concrete aging mechanisms such as leaching of calcium hydroxide and reaction with aggregates would be precluded. Since it is not evident that all Westinghouse PWR concrete containments were designed and constructed to all of these codes, standards and guides, verification of this issue is designated as Renewal Applicant Action Item No. 8.

Also in response to RAI No. 1, WOG replied that the GTR addresses Westinghouse PWR containment structures generically. Some isolated cases may exist where a degradation mechanism and effect such as leaching of calcium hydroxide may develop. These will be plant-specific issues which will be discussed within a license renewal application. BNL acknowledges WOG's evaluation that some of the aging mechanisms have not shown detrimental effects. Nevertheless, these aging mechanisms may produce detrimental effects in the future. Therefore, current mandated inspections in accordance with 10CFR50.55a/ASME Code Section XI, Subsection IWL, Examination Category L-A should be generically credited for aging management of concrete for license renewal. This issue is designated as Open Item No. 4.

Section 3.2.6 of the GTR concluded that there is no need for the identification of aging management options for aging effects caused by thermal embrittlement in concrete. In RAI No. 10 (NRC letter dated February 19,1998), the staff requested the WOG to justify this conclusion for the main steam line penetrations through containment where temperatures could reach 500^0 F, substantially higher than the 200^0 F limit in the ACI Code. In response, the WOG indicated that local temperatures beyond 200^0 F are not permitted because of ACI 349 code limits. For hot piping penetrations, cooling coils and/or insulation are needed to maintain local temperatures within the 200^0 F code limit.

This response does not fully address the concern because (1) many plants were not designed to ACI 349 and (2) it is not clear from the response whether all hot penetrations that exceed the 200^0 F code limit at all plants have cooling coils and/or insulation that maintain local temperatures within the 200^0 F code limit. Satisfaction of the 200^0 F local limit for concrete around hot penetrations should be addressed on a case-by-case basis in the applicant's License Renewal submittal. If an applicant cannot verify this, then a plant-specific aging management program would be needed to address elevated concrete temperature effects. This issue is designated as Renewal Applicant Action Item No. 9.

3.3 Aging Management Programs

Section 4.1 of the GTR states that the aging effects for the systems, structures, and components within the scope of the GTR are managed using current licensing basis (CLB) inspection and test programs based on ASME Code Section XI, Subsections IWE and IWL, and American Concrete Institute (ACI) codes. These programs include current plant maintenance, inspection, and testing programs that follow the 1992 Code Edition and Addenda of ASME Section XI, Subsections IWE and IWL, in compliance with 10 CFR 50.55a. WOG noted that in U.S. NRC SECY-96-080, the 1992 ASME Code, including the 1992 Addenda, of Section XI, Subsections IWE and IWL, was recognized by the NRC as effective in managing the aging effects associated with containment structures.

WOG recommended that a utility incorporate into its inservice inspection programs, for the extended period of operation, aging management programs (AMPs) that are based on the 1992 Code Edition, with 1992 Addenda, of ASME Section XI, Subsections IWE and IWL. Further, WOG also recommended that the modifications specified in SECY-96-080 (introduced in SECY-93-328, the proposed rule) to address NRC concerns related to tendon examinations and inaccessible areas should also be included in the AMPs

WOG identified seven AMPs that would serve as the basis for aging management at utility plants. GTR Table 4-2 provides a listing of the AMPs and the components, aging mechanisms and aging effects they address. The programs are: AMP-5.1 and AMP-5.2 to address freeze thaw in the concrete containment and shield buildings respectively, AMP-5.3 and AMP-5.4 to address aggressive chemical attack - corrosion in the concrete containment and shield buildings respectively, AMP-5.5 to address degradation of metal components such as the liner, containment shell, penetrations and airlocks/hatches, AMP-5.6 to address degradation of Post-Tensioning systems and AMP-5.7 to address foundation settlement. Descriptions of the AMPs are presented in GTR Sections 4.1.6 thru 4.1.11, with comprehensive summaries of each plan provided in GTR Tables 4-9 thru 4-15. Each AMP is discussed below.

The staff raised a number of questions that relate to all the AMPs. In RAI No. 4 (NRC letter dated February 19,1998), the staff requested that when specific codes, standards, or related documents are used or described in the evaluation of aging management for containment, the GTR should include the full title, edition, and the year of publication. This was not done for some of the documents such as ACI publications in Tables 4-10 and Table 4-12. In response the WOG stated that sufficient information is given to permit identification of the intended document. The list of references or bibliography provides the date and title. For some cases it may not be appropriate to provide the applicable year of publication because the GTR applies to all Westinghouse PWR plants which have different licensing bases. Where it is not possible to indicate the applicable year of publication, the WOG stated that it will be necessary for the utility to identify this information in their license renewal application. This will be addressed in the plant-specific license renewal application and is designated as Renewal Applicant Action Item No. 10.

Section 4.1.4 of the GTR addresses nondestructive examination/sampling inspection technology. In RAI No. 24 (NRC letter dated February 19,1998), the staff requested WOG to address the implementation of Appendix VII and Appendix VIII of ASME Code Section XI when conducting ultrasonic examinations of containment structures. In response, WOG stated that when implementing an aging management program that references Subsection IWE, and it is necessary to utilize augmented ASME Section XI NDE inspection methods, the training qualifications and certification of ultrasonic examination personnel will meet Appendix VII and

Appendix VIII. BNL finds WOG's response acceptable, however, this should be incorporated in the GTR. This issue is designated as Confirmatory Item No. 2.

In RAI Nos. 2, 22, and 23 (NRC letter dated February 19,1998), the staff requested WOG to discuss aging management for inaccessible areas of containment structures. In response to these RAIs, WOG stated that potential degradation of inaccessible areas for these aging mechanisms are addressed in Section 4.0 of the GTR. The aging management programs defined in the report meet the inaccessible area requirements based on 10 CFR 50.55a, which specifies evaluation of inaccessible areas when conditions exist in accessible areas that could indicate the presence of, or result in, degradation to such inaccessible areas.

WOG also stated that it recognized the working draft SRP-LR encourages the review, on a case-by-case basis, of inaccessible areas when conditions in accessible areas may not indicate degradation. WOG stated that this review would only be done if it is event-driven (e.g., occurrence of an accident). This is a generic concern which should be addressed in the GTR. This issue is designated as Open Item No.5.

3.3.1 AMP-5.1 & AMP-5.2 - Concrete Containment, Concrete Shield Building - Freeze-Thaw Degradation

The GTR indicates that two programs will be used to manage freeze-thaw in concrete, program AMP-5.1 for concrete containments and program AMP-5.2 for concrete shield buildings. The programs will be applied on a plant-specific basis for plants where this aging mechanism is recognized to occur. In program AMP-5.1, containment structures will be examined and maintained in accordance with Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category L-A, of the 1992 Code Edition with 1992 Addenda, of the ASME Code, and the guidelines for condition surveys provided in ACI 201.1R-68. In program AMP-5.2, shield building structures will be examined and maintained in accordance with the guidelines in ACI Codes and Standards including ACI-201.1R-68, ACI-207.3R-79 and ACI 224.1R-89 and ASTM Standard C823.

The two aging management programs (AMP-5.1 and 5.2) described above are acceptable to the staff to manage the aging effects resulting from freeze-thaw because they rely on appropriate, applicable codes and standards. However, because freeze-thaw has been identified as a plant-specific aging mechanism which is potentially significant only in colder geographic regions, the applicability of this aging mechanism and adherence to AMP-5.1 and AMP-5.2 needs to be specified by each license renewal applicant. Therefore, this issue is designated as Renewal Applicant Action Item No. 11.

3.3.2 AMP-5.3 & AMP-5.4 - Concrete Containment, Concrete Shield Building and Basemat - Aggressive Chemical Attack - Corrosion

The GTR indicates that two programs will be used to manage aggressive chemical attack and corrosion in below grade concrete: program AMP-5.3 for concrete containment and program AMP-5.4 for concrete shield building and foundation mat. The programs will be applied on a plant-specific basis for plants where groundwater chemistry and interior leakage provide an environment conducive to degradation by these mechanisms. In program AMP-5.3, accessible areas will be examined in accordance with Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category

L-A, of the 1992 Code Edition with 1992 Addenda, of the ASME Code. Groundwater quality and the identification of leakage on the inside of the containment would be monitored at each refueling outage.

If aggressive chemistry is indicated in the groundwater and/or soil, inspection of the concrete in the affected zone would be performed. Sample areas of exterior surfaces that are below the groundwater table would be visually inspected. Quoting from Section 4.1.7 of the GTR," If deterioration is found at the sample area, the acceptability of inaccessible areas is evaluated in accordance with the changes to 10 CFR 50.55a, as described in SECY-96-080. Concrete containments are evaluated using the revised rule para 50.55a (b)(2)(ix)(E), while steel liners and steel containments are evaluated using the revised rule para 50.55a (b)(2)(x)(A)." Compliance with 50.55a requires that the licensee evaluate the acceptability of inaccessible areas when conditions exist in accessible areas that could indicate the presence of or result in degradation to such inaccessible areas. Groundwater management (e.g. change water chemistry or redirect groundwater as necessary) is identified as an option when repairs are not feasible.

In program AMP-5.4 the concrete surfaces of the shield building and foundation mat will be examined in accordance with the guidelines in ACI Codes and Standards including ACI 201.1R-68, ACI 207.3R-79 and ACI 224.1R-89 and ASTM Standard ASTM C823. Monitoring will be performed to identify leakage of water in the shield building and, if chemistry is questionable, the quality of groundwater. The monitoring of leakage and water chemistry will be performed at every refueling outage while the inspections will be performed every five years. Corrective actions include: changing water chemistry, redirecting groundwater or repairs in accordance with ACI guidelines, as necessary.

The aging management programs AMP-5.3 and 5.4 described above are considered acceptable to manage the aging effects resulting from aggressive chemical attack- corrosion because they rely on appropriate, applicable standards. However, because the programs will be applied on a plant-specific basis for plants where groundwater chemistry and interior leakage provide an environment conducive to degradation by these mechanisms, the applicability of this aging mechanism and adherence to AMP-5.3 and AMP-5.4 needs to be specified by each license renewal applicant. This is designated as Renewal Applicant Action Item No. 12.

In RAI No. 19 (NRC letter dated February 19,1998), the staff requested additional information regarding the ground water chemistry monitoring program. Questions were raised relating to the effect of seasonal variation on the water chemistry and the technical basis for the water sample chemistry acceptance criteria. WOG provided the basis for the acceptance criteria. The staff has identified a concern regarding the effects of seasonal variation on the water chemistry. Since such information is plant-specific, this is designated as Renewal Applicant Action Item No. 13.

Because grease leakage in prestressed concrete containments has occurred at some plants, the staff requested, in RAI No. 28 (NRC letter dated February 19,1998), a discussion on how the aging effects of grease leakage into the concrete is being managed.

WOG responded that the examination and inspection of grease leakage, its significance, and its impact on the integrity of prestressed concrete containments would follow the ASME

Section XI, Subsection IWL requirements. WOG stated that if there are ingredients within the grease that would cause degradation of the concrete, the utility should consider this as part of a concrete aggressive chemical attack mechanism, and manage the effect during the license renewal period following the aging management program AMP-5.3. WOG classified the potential effect of grease on the shear load capability of the concrete structure as a plant-specific issue.

BNL finds WOG's response acceptable, except for the potential effect on shear load capacity. Since WOG has identified this as a plant-specific issue, it is designated as Renewal Applicant Action Item No. 14.

3.3.3 AMP-5.5 Liner, Steel Containment Shell, Penetrations, Coatings and Airlocks and Hatches - Embrittlement and Loss of Pressure Retention, Mechanical Wear, Fatigue, Corrosion, SCC, and TGSCC

The GTR indicates that program AMP-5.5 will be used to manage potential aging effects for steel containment shells, steel liners, coatings, penetrations, airlocks and hatches due to corrosion, SCC, TGSCC, embrittlement and loss of pressure retention, and fatigue. In AMP-5.5, the components will be examined and maintained in accordance with ASME Code, Section XI, Subsection IWE "Requirements for Class MC and Metallic Liners of Class CC Components of Light-Water Cooled Power Plants", 1992 Edition with 1992 Addenda, and the requirements of Appendix J Leak Rate Testing. IWE examination categories are E-A, E-B, E-C, E-D, E-F, E-G, and E-P from the specified code edition (1992 with 1992 addenda). In response to RAI No. 11, WOG acknowledged that incorrect examination categories (corresponding to the 1989 edition) are listed in Table 4-13. This is Confirmatory Item No. 4. The program will also include the identification and monitoring of leakage inside containment. For leakage, monitoring will be performed at each refueling outage and the corrective actions include the removal of standing water and the cleanup and restoration of affected surfaces.

In RAI No. 26 (NRC letter dated February 19,1998), the staff requested a discussion pertaining to the performance of examinations specified in Examination Category E-B for pressure retaining welds and Examination Category E-F for pressure retaining dissimilar metal welds of Subsection IWE of ASME Section XI Code (Reference 3) for license renewal.

WOG indicated that pressure retaining welds (Examination Category E-B) are visually inspected using the VT-1 examination method. Examination methods for suspect areas and augmented inspections, alternate examination methods, inspection frequency, acceptance criteria, corrective actions, and confirmation follow the IWE requirements as defined in Table 4-13 of the GTR for aging management AMP-5.5. Pressure retaining dissimilar welds (Examination Category E-F) are inspected using surface examination methods as defined in Subsection IWA-2220 of Section XI. Alternate examination methods, inspection frequency, acceptance criteria, corrective actions, and confirmation follow the IWE requirements as defined in Table 4-13 of the GTR for aging management AMP-5.5. Since the performance of examination for Categories E-B and E-F follows Subsection IWE of the Code, BNL considers this acceptable.

Stress corrosion cracking (SCC) is a concern for dissimilar metal welds, and in the case of stainless steel bellows assemblies, SCC may be significant if the material is not shielded from a corrosive environment. For the period of extended operation, examination Categories E-B and

E-F and augmented VT-1 visual examination of bellows assemblies and dissimilar metal welds are warranted. Each license renewal applicant needs to define its plant-specific program to address this concern. This is designated Renewal Applicant Action Item No. 15.

Coating degradation is listed in the executive summary of the GTR as an aging mechanism that requires an aging management program. Although it is not listed as a degradation mechanism in Table 2-16, it is listed as an aging mechanism affecting the liner and managed by AMP-5.5, in Table 2-17. In the list of aging effects, Table 2-18, it is listed and characterized as a secondary effect. The aging evaluation for this mechanism is provided in GTR Subsection 3.2.15.

In Section 3.2.15 of the GTR, WOG concluded that there is no need for an aging management program to address coating degradation. Instead, the ISI programs are relied on to detect the aging effects of coating degradation and to provide criteria for the acceptance of repairs and subsequent inspections. It was further concluded that the loss of coating does not directly result in an aging effect although corrosion could result from the loss of the coating. Referring to the description of AMP-5.5, the staff notes that no unique inspection or evaluation for coatings is referenced. No specific statement regarding the repair of coatings is provided, although repairs of damaged areas would follow the requirements and recommendations of the ASME IWA and IWE programs.

BNL concludes that AMP-5.5 does not include any provision to monitor and maintain the condition of protective coatings on steel elements of containment. Most, if not all, licensees have existing coatings programs which can be credited for license renewal. Monitoring and maintenance of protective coatings should be identified as an AMP for steel elements of containment. Consequently, each applicant should discuss its plant-specific coatings program and specify whether it is being credited for managing aging of containment steel elements. This is designated Renewal Applicant Action Item No. 16.

3.3.4 AMP-5.6 Containment Post-Tensioning System Degradation - SCC, Corrosion, Loss of Prestress Loading

The GTR indicates that program AMP-5.6 will be used to manage potential degradation of containment post-tensioning systems. The program will be applied on a plant-specific basis to those plants that include post-tensioning systems in their containment design. In the program the tendon systems will be examined, tested, and maintained in accordance with Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category L-B, Unbonded Post-Tensioning System, of the 1992 Code Edition with 1992 Addenda of the ASME Code.

In addition to the above, Section 4.1.10 of the GTR recommends that the utility inspection program also include four specific recommendations for tendon examination addressed in Regulatory Guide 1.35, Rev. 3 and an evaluation of the potential degradation of adjacent inaccessible areas. Since these requirements are also specified in 10 CFR 50.55a(b)2(ix), compliance with these requirements must be addressed as part of the aging management program in each plant-specific license renewal application. This issue is designated as License Renewal Applicant Specific Action Item No.17.

A concern was raised in RAI No. 27 (NRC letter dated February 19,1998) regarding the effect of elevated temperature on the prestressing force of tendons. Elevated temperature can develop due to sun exposure or proximity to hot penetrations. The concern was raised because the selection of a relatively few sample tendons may not include tendons that are affected by the elevated temperatures.

The staff has subsequently concluded in its resolution of this generic license renewal issue that the effects of elevated temperature on tendon prestress losses are adequately managed by the existing tendon surveillance and testing programs. Therefore, this issue is no longer significant.

3.3.5 AMP-5.7 Foundation - Settlement

The GTR indicates that program AMP-5.7 will be used to monitor the potential differential settlement of concrete foundations on soil. This program will be applied on a plant-specific basis to those plants recognized to be susceptible to settlement due to: the soil groundwater characteristic on which the plant is founded, soft soil conditions, or the use of piles in the foundation. In the program, a baseline inspection would be made to document settlement and building gap measurements and building misalignments. Thereafter, an evaluation at a frequency of at least once every five years is recommended. The inspections are to be performed by a qualified engineer and appropriate actions are to be taken to mitigate any conditions detrimental to continuous plant operation. The GTR recognizes that for the plants susceptible to settlement, programs to monitor changes in the groundwater table and to detect potentially significant settlement are included in the CLB.

In RAI No. 21 (NRC letter dated February 19,1998), the staff requested a description of how the settlement monitoring program ensures that differential settlement of the containment basemat does not exceed the design criteria for the containment structure and its base mat, including sites that may be experiencing significant changes in ground water conditions. In addition, a description of how the program satisfies the elements of an aging management program as defined in the working draft SRP-LR was requested.

In its response, WOG indicated that most of the settlement occurs within the first 5 to 6 years of operation. Only those plants with significant long-term settlement issues will be affected by this age-related degradation mechanism. The settlement monitoring program for those plants susceptible to settlement is not within the scope of the GTR. Details of the settlement monitoring program would be provided in the license renewal application. Since this will be addressed on a plant-specific basis, this issue is designated as Renewal Applicant Action Item No. 18.

In RAI No. 25, the staff indicated that if sub-foundation layers of porous concrete are used in the construction of a containment concrete basemat, then the management of aging effects due to erosion of cement should be discussed. WOG responded that this type of aging effect has not been addressed in the report because this type of construction is considered to be limited. If a plant uses porous concrete for sub-foundation layers beneath the basemat of a containment the utility would have to address this construction and aging effect in its plant-specific license renewal application. Therefore, this issue is designated as Renewal Applicant Action Item No. 19.

As stated in Section 2.3 above, the GTR listed only six (6) attributes to form the basis for each aging management program. However, the “Draft Standard Review Plan for the Review of License Renewal applications for Nuclear Power Plans”, dated April 21, 2000, identifies ten (10) elements (attributes), as appropriate, for an acceptable AMP. The GTR predates the Draft standard Review Plan for the review of Licencing Renewal applications for Nuclear Power Plans, and states in Section 4.0 that the report only presents program attributes for the AMPs, and that plant-specific details of the AMPs will be developed during the preparation of license renewal applications. Therefore, applicants for license renewal will be responsible for developing and describing the plant-specific AMPs with each AMP consisting of ten (10) elements. This issue is designated as Renewal Applicant Action Item No. 20.

3.4 Time-Limited Aging Analyses

Time-limited aging analyses (TLAAs) are defined in 10 CFR 54.3 as those licensee calculations and analyses that:

(1) Involve systems, structures, and components within the scope of license renewal, as stated in 10 CFR 54.4(a);

(2) Consider the effects of aging;

(3) Involve time-limited assumptions defined by the current operating term, for example, 40 yrs.;

(4) Were determined to be relevant in making a safety determination;

(5) Involve conclusions or provide the bases for conclusions related to the capability of the system, structure, or component to perform its intended functions, as stated in 10 CFR 54.4(b); and

(6) Contained or incorporated by reference in the current licensing basis.

10 CFR 54.21(c)(1) requires the applicant to demonstrate that:

(i) The analyses remain valid for the period of extended operation;

(ii) The analyses have been projected to the end of the period of extended operation; or

(iii) The effects of aging on the intended functions(s) will be adequately managed for the period of extended operation.

The TLAAs evaluated in the GTR for containment structures are

- Loss of prestress force loads in prestressing systems
- Fatigue of penetration anchors
- Fatigue of penetration bellows
- Fatigue of mechanical penetrations

The results of the evaluations are presented in Tables 3-3 and 3-4 of the GTR.

Loss of prestress forces in tendons require that the analyses be updated for the period of extended operation. For mechanical penetrations, WOG states that a utility may need to perform a fatigue analysis to show that an existing analysis remains valid for the period of extended operation. As an alternate to performing analyses, WOG states that a utility may choose to adequately manage the effects of aging using the ASME Section XI surveillance and testing programs. For penetration anchors and penetration bellows, WOG states that the latter approach is applicable.

In RAI No. 12 (NRC letter dated February 19,1998), the staff requested the WOG to specify the specific structural components designed for fatigue loadings and whether fatigue is a TLAA for license renewal. The RAI response indicated that the following components were evaluated in Section 3.2 of the GTR for fatigue:

Fatigue at Penetration Anchors
Fatigue - Reinforcing Steel
Fatigue at Attachments and Discontinuities - Liner, Airlocks, and Hatches
Fatigue - Mechanical Penetration Bellows
Fatigue - Mechanical (Piping) Penetrations
Fatigue - Airlock and Hatches
Fatigue - Free Standing Steel Containment

In Section 3.3 of the GTR, fatigue is identified as a TLAA for the following three components:

Concrete Containment Penetration Anchors
Mechanical Penetration Bellows
Mechanical Penetrations associated with piping

BNL finds response to RAI No.12 acceptable. However, additional questions were raised regarding the evaluation of fatigue in RAI Nos. 15, 16, 17, and 18. After review of the responses to these RAIs, three (3) renewal applicant action items are identified:

- Two options are presented in the GTR for addressing TLAAs related to fatigue of steel components: update an existing design fatigue calculation to account for the additional years of operation, or utilize ASME Code Section XI surveillance and testing programs. Per 10 CFR 54.21(c)(1)(i) and 54.21(c)(1)(ii), the staff finds the first option acceptable. The second option (corresponding to 10 CFR 54.21(c)(1)(iii)) allows the component to be included in an ASME Code Section XI ISI program. This option would allow the CLB fatigue Section III cumulative usage factor (CUF) to be exceeded during the period of extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to request staff review and approval on a case-by-case basis. For those components where no CLB fatigue TLAA exists (not addressed in 10 CFR 54.21), aging due to fatigue can be addressed by either a Section III fatigue analysis in accordance with the CLB (including the additional years for the license renewal period), or an aging management program. This issue is designated as Renewal Applicant Action Item No. 21.

- Applicants should identify plant-specific components with CLB fatigue analyses and provide the corresponding cumulative fatigue usage through the period of extended operation. Since this is a plant-specific issue, it is designated as Renewal Applicant Action Item No. 22.

- The plant-specific components which are subject to fatigue but do not have a fatigue analysis need to be identified and the plant-specific technical basis for managing the effects of fatigue needs to be described. This issue is designated as Renewal Applicant Action Item No.23.

3.4.1 Loss of Prestress Force Loads in Prestressing Systems

The loss of prestress force loads in the prestressing system was determined by WOG to meet all six criteria for defining a TLAA. Regarding the requirements of 10 CFR 54.21(c)(1), WOG determined:

> the analyses of prestress force loss require an update for the period of extended operation,
>
> the analyses have been projected to the end of the extended period of operation, and
>
> the effects of aging on the intended functions will be adequately managed for the extended period of operation with aging management program AMP-5.6

In RAI No. 13 (NRC letter dated February 19,1998), the staff requested WOG to discuss how the prestress loss rate is determined for the additional 20 years of operation to ensure that its intended function is maintained. The staff stated that Table 4-14 of the GTR does not address calculations for the prestress loss as a consideration in the AMP. The staff considers tendon prestress evaluation as a TLAA that needs to be evaluated for license renewal in accordance with 10 CFR 54.21(c).

WOG's response indicated that a description of how the prestress loss rate is determined is not given in the GTR because it is considered a plant-specific issue that should be addressed in the applicant's license renewal submittal. Since this will be addressed on a plant-specific basis, the issue is designated as Renewal Applicant Action Item No. 24.

3.4.2 Fatigue of Penetration Anchors

The evaluation of fatigue TLAAs for penetration anchors is based on Option (iii) of 10 CFR 54.21(c)(1). The GTR proposes to manage these effects by existing Section XI surveillance and testing programs. For components where CLB fatigue TLAAs exist, this would allow the CLB Section III CUF to be exceeded during the period of extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to request staff review and approval on a case-by-case basis. For components where CLB fatigue TLAAs do not exist (not addressed in 10 CFR 54.21), aging effects due to fatigue can be addressed by either a Section III fatigue analysis (including the additional years for the period of extended operation) or by adequately managing these effects for the period of extended operation. This issue is addressed by Renewal Applicant Action Item No. 21.

3.4.3 Fatigue of Penetration Bellows

The TLAA for penetration bellows is identical to the TLAA for penetration anchors. The evaluation presented in Section 3.4.2 above also applies to penetration bellows.

3.4.4 Fatigue of Mechanical Penetrations

The evaluation of fatigue TLAAs for mechanical penetrations is based on Options (i) and (ii) of 10 CFR 54.21(c)(1), which state that existing CLB fatigue analyses should remain valid for the period of extended operation, or be projected to the end of the period of extended operation. The staff finds this acceptable. The GTR also indicates in Note (4) to Table 3-4 that managing the aging effects due to fatigue for the period of extended operation is an option in lieu of performing additional analyses. This option would allow the component to be included in an ASME Code Section XI ISI program, and would permit the CLB fatigue Section III CUF to be exceeded during the period of extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to request staff review and approval on a case-by-case basis. This issue is addressed by Renewal Applicant Action Item No. 21.

4.0 CONCLUSIONS

BNL has reviewed the WOG GTR (Reference 2) and the responses to the staff's RAIs submitted by WOG. On the basis of its review, BNL concludes that, upon resolution of the open and confirmatory items discussed in Sections 4.2 and 4.3 below, the WOG GTR provides an acceptable demonstration that the aging effects for containment structure components within the scope of the GTR will be adequately managed, so that there is reasonable assurance that these containment structure components will perform their intended functions in accordance with the CLB for the period of extended operation. BNL also concludes that the GTR provides an acceptable evaluation of time-limited aging analyses for the period of extended operation.

Upon successful resolution of the open and confirmatory items, any WOG member plant may reference this GTR in a license renewal application to satisfy the requirements of 10 CFR 54.21(a)(3) for demonstrating that the effects of aging on the components within the scope of this GTR will be adequately managed and to satisfy the requirements of 10 CFR 54.21(c)(1) for demonstrating that appropriate findings are made regarding evaluation of time-limited aging analyses for the period of extended operation.

BNL also concludes that (1) subject to the resolution of open and confirmatory items, (2) upon satisfaction of the renewal applicant action items set forth in Section 4.1 below, and (3) upon inclusion of the aging management programs and the TLAA evaluations contained in this GTR in the FSAR supplement, referencing this GTR in a license renewal application will provide the staff with sufficient information to make the necessary findings required by 10 CFR 54.29(a)(1) and (a)(2) for containment structure components within the scope of this GTR.

4.1 Renewal Applicant Action Items

The following renewal applicant action items are to be addressed in the plant-specific license renewal application when incorporating the WOG GTR in a renewal application:

(1) The license renewal applicant will (i) verify that its plant is bounded by the GTR, (ii) commit to programs described as necessary in the GTR to manage the effects of aging during the period of extended operation and (iii) verify that the programs committed to are conducted in accordance with appropriate regulatory controls (e.g. 10 CFR Part 50, Appendix B). Further, the renewal applicant will identify any deviations from the aging management programs which this GTR describes as necessary to manage the effects of aging during the period of extended operation or to maintain the functionality of the containment structure, and deviations from other information presented in the GTR (e.g., materials of construction). The renewal applicant will evaluate any such deviations in accordance with 10 CFR 54.21(a)(3) and (c)(1) on a plant-specific basis.

(2) A summary description of the programs and activities for managing the effects of aging and the evaluation of TLAAs is to be provided in the license renewal FSAR supplement, in accordance with 10 CFR 54.21(d).

(3) Individual plant applicants will need to provide a comprehensive list of structures and components subject to an aging management review and the methodology used to develop this list as part of their license renewal applications. Any components determined by the applicant to be subject to an aging management review for license renewal but not within the scope of the GTR are required to be addressed in the license renewal application.

(4) Provide cross-section drawings for the containment structures; and detailed drawings of the sand pocket region and other plant-specific features, if applicable.

(5) Provide legible drawings of equipment and penetration details as part of the description of the containment structure components.

(6) For prestressed concrete containments, indicate whether the tendon access gallery is included as a containment structure component, subject to an aging management review. If it is, provide the details of the aging management review and the credited aging management program. If not, provide a technical basis for exclusion, which addresses the potential for degradation of the lower vertical tendon anchors resulting from the environmental conditions in the tendon access gallery.

(7) Discuss plant-specific operating experience relevant to age-related degradation of containment structure components and how this experience has been considered in the aging management review.

(8) For concrete containments, verify that the original plant design and construction specifications satisfy the criteria which are relied upon to exclude leaching of calcium hydroxide and reaction with aggregates as significant aging mechanisms. If this is

not the case, describe the aging management program which is credited to manage the aging effects associated with these aging mechanisms.

(9) For concrete containments, discuss whether local heating of containment concrete at the Main Steam and/or any other penetrations results in sustained concrete temperatures exceeding 200^{o}F. If this condition exists, provide an aging management review and describe the credited aging management program.

(10) Provide governing edition and/or date for codes and standards which are plant-specific.

(11) Specify whether freeze-thaw is an applicable aging mechanism which will be managed by AMP 5.1 or AMP 5.2, as applicable. If not, provide the technical basis for exclusion.

(12) Specify whether aggressive chemical attack is an applicable aging mechanism which will be managed by AMP 5.3 or AMP 5.4, as applicable. If not, provide the technical basis for exclusion.

(13) Provide details of the groundwater monitoring program and discuss potential seasonal variation in ground water chemistry.

(14) For prestressed concrete containments, discuss plant experience with respect to tendon grease leakage and, if applicable, how it is being managed; also discuss the potential effects of grease leakage on the shear load capacity of the containment structure.

(15) Each license renewal applicant needs to define its plant-specific program to address the stress corrosion cracking (SCC) problem because it is a concern for dissimilar metal welds, and in the case of stainless steel bellows assemblies, SCC may be significant if the material is not shielded from a corrosive environment. For the period of extended operation, examination Categories E-B and E-F and augmented VT-1 visual examination of bellows assemblies and dissimilar metal welds are warranted.

(16) Discuss the plant-specific coatings monitoring and maintenance program and specify whether it is credited as an AMP for containment steel elements.

(17) For prestressed concrete containments, specify whether post-tensioning system degradation will be managed by AMP 5.6 (Section XI, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Power Plants, Examination Category L-B, Unbonded Post-Tensioning System, 1992 Code Edition with 1992 Addenda of the ASME Code) and the additional requirements delineated in 10 CFR 50.55a (b)2(ix). If not, provide the technical basis for exclusion.

(18) Specify whether settlement of the containment foundation is an applicable aging mechanism which will be managed by AMP 5.7. If not, provide the technical basis for exclusion.

(19) Identify whether erosion of porous concrete subfoundation layer is an applicable aging mechanism; if applicable, provide an aging management review and describe the credited aging management program.

(20) As stated in Section 2.3 above, the GTR listed only six (6) attributes to form the basis for each aging management program. However, the “Draft Standard Review Plan for the Review of License Renewal applications for Nuclear Power Plans”, dated April 21, 2000, identifies ten (10) elements (attributes), as appropriate, for an acceptable AMP. The GTR predates the Draft standard Review Plan for the review of Licencing Renewal applications for Nuclear Power Plans, and states in Section 4.0 that the report only presents program attributes for the AMPs, and that plant-specific details of the AMPs will be developed during the preparation of license renewal applications. Therefore, applicants for license renewal will be responsible for developing and describing the plant-specific AMPs with each AMP consisting of ten (10) elements.

(21) The WOG GTR indicates that the license renewal applicant may update an existing design fatigue analysis to account for the additional years of plant operation, or manage the effects of the aging mechanism through aging management programs. The GTR uses AMP 5.5 for managing the effects of fatigue during the renewal license period, and basically endorses the ASME Code Section XI surveillance and testing program. For components where CLB fatigue TLAAs exist, this option would allow the CLB fatigue Section III CUF to be exceeded during the period of extended operation. The staff has not endorsed this option on a generic basis at this time. An applicant wishing to pursue this option would have to obtain staff review and approval on a case-by-case basis. For components where CLB fatigue TLAAs do not exist (not addressed in 10 CFR 54.21), aging effects due to fatigue can be addressed by either a Section III fatigue analysis (including the additional years for the period of extended operation) or by adequately managing these effects for the period of extended operation.

(22) Specify the containment structure components and provide plant-specific details of the TLAAs for prediction of cumulative fatigue usage through the period of extended operation.

(23) Specify those containment structure components for which fatigue is an applicable aging mechanism, but no CLB fatigue analysis based on a 40 year plant life exists. In addition to implementation of AMP 5.5, the requirements of 10 CFR 50.55a should be met.

(24) For prestressed concrete containments, provide plant-specific details of the TLAA for prediction of tendon prestress losses through the period of extended operation.

4.2 Open Items

Based on BNL's review of the WOG GTR and the WOG responses to NRC's RAIs, the following open items need to be resolved:

(1) The following intended functions, which are specific to containment structures, should be added to the discussion on intended functions of the GTR:

1. Providing structural or functional support of safety-related systems, structures, and components following a design basis accident (DBA).

2. Serving as an external missile barrier consistent with design basis commitments. The containment structure is designed for all missile forces.

3. Providing a heat sink during a DBA or station blackout in addition to the spray system.

(2) The GTR identified structural connections as a containment structure component that requires aging management in Table 2-1. However, there is no definition and description of structural connections in GTR Section 2. A definition and description for structural connections are needed.

(3) The GTR identified embedments as a containment structure component that requires aging management in Table 2-1. However, there is no definition and description of embedments in GTR Section 2. A definition and description for embedments are needed.

(4) The aging effects in concrete due to leaching of calcium hydroxide and alkali aggregate reaction are identified in the GTR as not requiring aging management. This is unacceptable because plant-specific evaluation of their applicability is needed. These aging mechanisms, if applicable, can be managed by ASME Code, Section XI, Examination Category L-A. This is a mandated CLB inspection program, which will continue into the period of extended operation.

The GTR identifies examination category L-A of IWL to manage freeze-thaw (AMP5.1) and to manage aggressive chemical attack and rebar degradation (AMP5.3), where applicable. According to the GTR, it may not be necessary to credit examination category L-A to manage these aging mechanisms, if on a plant specific basis, the applicant determines these aging mechanisms are not applicable. Consequently, in these cases, examination category L-A would not be credited to manage concrete degradation for License Renewal.

In general, it is intended that maximum credit be taken for existing mandated programs (e.g., examination category L-A) in the development of an applicant's aging management program. Implementation of examination category L-A as an aging management program for containment concrete should be specified in the GTR.

(5) The WOG GTR does not commit to inspection of inaccessible areas when there is no indication of degradation of adjacent accessible areas, except when the potential for degradation is "event driven"; i.e., some unusual event has occurred which has the potential to degrade inaccessible areas of the containment structures. This qualification was not considered acceptable. Therefore, the GTR cannot be referenced by license renewal applicants for managing aging of inaccessible areas. Plant-specific resolution of this issue will be required.

4.3 Confirmatory Items

Based on the BNL review, the following Confirmatory Items need to be addressed by WOG:

(1) RAI 29 identified errors in Section 2 of the WOG GTR concerning the range of basemat thicknesses for Type 1 and Type 3 containments. In the RAI response, the WOG acknowledged the errors and provided a corrected list of basemat thickness range for Types 1, 2, and 3 containments.

(2) RAI 24 addresses the implementation of ASME Appendix VII and Appendix VIII of Section XI, when ultrasonic examination is used. In the RAI response, the WOG acknowledged the necessity of implementing Appendices VII and VIII when ultrasonic examination is used.

(3) RAIs 6, 7, 30 and 31 identified text errors in Table 3-1. In the RAI responses, the WOG acknowledged these errors and identified the corrected text.

(4) RAI 20 identified that AMP 5.5 refers to IWE examination categories taken from the 1989 Code Edition, instead of the 1992 Code Edition. In the WOG RAI response, this error is acknowledged and the correct examination categories are identified.

(5) RAI 33 requested missing publication dates for references and bibliography documents listed in Section 6.0 of the WOG GTR. The requested dates were provided in the WOG response to the RAI.

5.0 REFERENCES

(1) 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," published in Federal Register, Vol. 60, No. 88, pp. 22461-22495, May 8, 1995.

(2) WCAP-14756, "Aging Management and Evaluation for Pressurized Water Reactor Containment Structure," Westinghouse Owner's Group, December 1996.

(3) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," the American Society of Mechanical Engineers, 1992 Edition with 1992 Addenda.

(4) "Standard Review Plan for the Review of License Renewal Applications for Nuclear Power Plants," Working Draft, September 1997.

(5) Letter to Document Control Desk (NRC), from T.V. Greene (WOG), dated December 11, 1996, submitting WCAP-14756, Revision 0, “Aging Management Evaluation for Pressurized Water Reactor Containment Structures.”

(6) Letter to R.A. Newton (WOG), from R.K. Anand (NRC), dated February 19, 1998, transmitting “Request for Additional Information Regarding the Westinghouse Owners Group Topical Report WCAP-14756, Revision 0, December 1996.”

(7) Letter to Document Control Desk (NRC), from R.A. Newton (WOG), dated March 17, 1998, “Planned Date for Completion of Responses to RAI’s.”

(8) Letter to R.K. Anand (NRC), from R.A. Newton (WOG), dated May 29, 1998, Response to NRC Request for Additional Information on WOG Generic Technical Report WCAP-14756, “License Renewal Evaluation: Aging Management Evaluation for Pressurized Water Reactor Containment Structures.”

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